THURSDAY, SEPTEMBER 18, 1919.

SCIENCE AND SOCIALITY.

Annals of the Philosophical Club of the Royal Society, written from its Minute Books. By Prof. T. G. Bonney. Pp. x + 286. (London: Macmillan and Co., Ltd., 1919.) Price 15*s.* net.

THE Royal Society is not only our most eminent body of men of science, but also one of the oldest and perhaps the most illustrious of all the learned academies of the world. To be elected into the number of its Fellows has always been regarded by the cultivators of science in this country as one of the highest distinctions to which they can aspire. To "shine in the dignity of F.R.S." was a coveted honour in the days of the "Dunciad," and is in even higher repute to-day. The recent publication of two volumes, however, shows that this "dignity" has from the first been combined with the saving grace of strong social and convivial instincts. The first of these volumes, "Annals of the Royal Society Club" (reviewed in NATURE of August 30, 1917), showed that the philosophers, while they doubtless conducted their scientific investigations and discussions with all the zeal and solemnity credited to them, were at the same time fond of the free, personal intercourse of the dinner-table. In true English fashion, they met in some tavern, and after two or three hours of pleasant talk, adjourned to the meeting of the society; or, if that meeting took place earlier in the day, they dined together after the scientific discussions were over. There is, indeed, some reason to believe that the Royal Society itself may have been actually born in a coffee-house. We know how much Samuel Pepys enjoyed these prandial meetings. It was not, however, until after his time that the choicer spirits formed themselves into a dining fraternity, with formal rules and a limited membership, the president of the society being chairman. They sat down weekly before a portentous bill of fare and with the spirit of true deipnosophists,

> Tried all *hors-d'œuvres*, all liqueurs defined,
> Judicious drank, and greatly daring dined.

Thus arose the "Royal Society Club" in the early part of the eighteenth century. Since then, while one generation has followed another, and Presidents and Fellows in long succession have come and gone, the Club still flourishes more vigorously than ever. It has migrated from tavern to tavern, from the City westwards to the precincts of Burlington House, and has learnt to dine from a less ample and miscellaneous cuisine, now still further retrenched by the war and the high cost of food. Yet it still maintains the hospitality which has always been one of its prominent features.

After the Royal Society Club had lived for rather more than a century, a number of the younger and more actively scientific Fellows of the Society began to be increasingly dissatisfied with the way in which the elections into the membership were conducted, and they put such pressure on the council as eventually to lead to a complete and salutary reform of that and other grievances. These ardent innovators, having purged the Society in 1847, may have thought of directing the tide of purgation into the Club. Any serious change in that social institution, however, even if considered desirable, would not have been easy of accomplishment. The triumphant reformers included in their number some nine members of the Club, but years would obviously have to pass before the rest of the active brigade could obtain admission. Besides, the atmosphere of the Club may have been too close and conservative for the comfort of the innovators, who would not be likely to find there much sympathy with their iconoclastic determination to keep a vigilant eye upon the doings of the council. They accordingly resolved to found a new dining confraternity, which was ultimately named the Philosophical Club, the history of which has now been compiled by Prof. Bonney in the second of the two volumes above referred to.

The aims for which this fresh organisation was created were more ambitious than those of its forerunner, and went much beyond social intercourse among members. In the language of its founders it was meant "to promote as much as possible the scientific objects of the Royal Society; to facilitate intercourse between those Fellows who are actively engaged in cultivating the various branches of natural science and who have contributed to its progress; to increase the attendance at the evening meetings [of the Society]; and to encourage the contribution and discussion of papers." Its numbers were limited to forty-seven, all of whom must be Fellows of the Royal Society and likewise authors of a paper published in the Transactions of one of the Chartered Societies, or of some work of original research in natural science. It was further provided that at least thirty-five of them must be resident within ten miles of the London General Post Office. They dined once a month at half-past five o'clock, and adjourned at a quarter past eight, when they were each expected to attend the meeting of the Society, unless unavoidably prevented. Perhaps the rule which most strongly marked them off from the older club was that which formally excluded all strangers from their meetings, with the exception of scientific foreigners temporarily visiting this country. Thus from the genial hospitality which had always distinguished the Royal Society Club and had been so useful in bringing men of letters, of art, of politics, of the Navy and Army, of public life, and of commerce and industry into contact with the men of science, the Philosophical Club, in its zeal for the prosecution of science, deliberately separated itself. Possibly to make amends for this abnegation of variety from the outside, it was customary for the chairman to invite the members present to make communications to the meeting on any subject of special

scientific interest, and the treasurer was instructed to record such communications in the minutes.

The two clubs continued for fifty-four years to live apart and in amity. But the fervid reforming zeal of the younger fraternity, having gained its first object, and having no obvious cause for further activity, gradually slackened. Many Fellows of the Society were members of both clubs, and it slowly dawned upon even the most conservative intellects that the co-existence of two dining clubs in connection with the same society was inconvenient and unnecessary. At last, in the summer of 1901, the Philosophical was formally incorporated with the Royal Society Club.

The "Annals" of the older corporation having been published in the summer of 1917, it was unanimously decided that the history of the younger fraternity should also be put into the more durable form of print, and that the task of compiling the narrative should be entrusted to Prof. Bonney, who happened to be the oldest surviving member of the dissolved club. It required no little courage to undertake this labour, and the veteran professor deserves the best thanks of the united Club and of the public for having accomplished it. His volume of "Annals of the Philosophical Club" is divided by him into two sections. The first of these, dealing with the business done at the meetings, in chronological order from the beginning to the close, shows from year to year the organisation and work of the club, the gradual disappearance of the old members and the advent of their successors. To the minutes that record these particulars the editor has added a short but adequate biographical notice of each of the new members.

The second and more interesting and important section contains the reports of the verbal "communications" made at the meetings, in chronological order, from May 6, 1847, when the institution was fairly started on its career, down to the time of the amalgamation of the two clubs. It was these communications which gave its distinctive character to the Philosophical Club, and it was well that this feature of its existence should be faithfully recorded. Prof. Bonney must have had difficulty in choosing how best to deal with them. He finally decided to place them all together by themselves in his second section, keeping them in chronological order under the dates of the successive meetings at which they were made. He has given us the whole available material, and has evidently treated it with the most patient care, taking infinite pains to verify and illustrate the text. Nevertheless, as a matter of convenient and effective arrangement we venture to think that it would have made the book more attractive had the two sections been fused into one continuous narrative—in other words, had the "communications," instead of being divorced from the account of the business meetings, been inserted, where they were actually made, after the business. At many meetings there was no business, and no mention of these meetings was required in section i. of the volume, but on turning to section ii. we may find for the same year a succession of meetings recorded, at which various communications were made. Thus the whole doings of the club in the year 1867 are comprised in eight lines in the first section, while in the second section reference is made to seven meetings in that year, each marked by communications which occupy in all four pages of the volume. Again, the business transacted in 1869 is summed up in two short lines, while in the second section the communications made at no fewer than eight meetings in that year cover three pages. We feel that the intercalation of these statements and discussions in the account of the more formal business would have gone far to relieve the narrative of the history of the club in section i., which, save for the editor's luminous little biographies, is confessedly of only limited interest.

Section ii. forms a truly remarkable record of the after-dinner talk of a body of the foremost men of science of our time. The topics mentioned or discussed range over the whole realm of Nature, from the centre of the earth to the furthest nebula. We are let, as it were, into the private study or the laboratory of the scientific worker; we are permitted to hear the earliest outlines of a discovery from the lips of the man who made it; we seem to be in the highest or inner council of science, listening to the words of its most trusted leaders. The entries are sometimes provokingly brief, yet so interesting that had one been there the temptation would have been great to ask the speaker to go on, or to request the treasurer to report the communication in full. The whole collection of communications is an amazing *olla podrida*, to be read only in little snatches at a time, and bearing somewhat the same relation to the speakers and their audience that the crushed and faded flowers of a herbarium do to their beauty as they lived. The perusal of it, however, cannot but impress on the reader a profound respect for the Philosophical Club and a conviction that this club must have been an institution of great scientific driving power and that when it was amalgamated with the Royal Society Club it introduced fresh healthy blood into the older corporation. Its "Annals," therefore, well deserved to be compiled, and the volume in which Prof. Bonney has told the story will take its place among the permanent records of the progress of science in the nineteenth century.

ARCH. GEIKIE.

BOTANY OF CULTIVATED PLANTS.

The Botany of Crop Plants. A Text and Reference Book. By Prof. W. W. Robbins. Pp. xx+681. (Philadelphia: P. Blakiston's Son and Co., 1917.) Price 2 dollars net.

IN the prefatory words of the author, "the issuance of this book has been stimulated in part by the expressed need . . . for a text or reference

book which will give the student a knowledge of the botany of common orchard, garden, and field crops. . . ." A text-book which achieved this object would be indeed a boon, for, with the exception of Percival's "Agricultural Botany," we know of no book which treats of economic plants in such a way as to expound the principles of botanical science and to provide knowledge directly useful to the person interested in the cultivation of food crops.

The method adopted by the author is to give a rapid exposition of botanical principles—histological, physiological, genetical, and morphological—in the course of sixty-seven pages, and then to treat in some detail the series of crop plants of field, garden, and orchard.

This method is open to the fatal objection that it evades the first duty of the teacher, which is so to select and present common facts that the essential generalisations, which cohere them into a scientific system, either suggest themselves to the student's mind, or, at all events, appear natural and convincing when the teacher, as is often the case, is compelled by the defectiveness of his method, or the indifference of his students, to expound them.

Instead of attempting this the author is content to hand out the usual stock of botanical facts. He begins by talking about undifferentiated plants and a thallus (p. 1), tells the student in p. 2 that the tendril of a pea is morphologically a leaf, and a potato tuber a modified stem, when, of course, the duty of the teacher is to promote the discovery by the student of these facts, and thereby to stimulate interest, illustrate morphological principles, and train the eye and mind to see essential things.

Histology is dealt with in chap. ii. in six pages, and the student is told sundry facts—that leucoplasts and chloroplasts exist, that protoplasm is a "proteid" and that it feels slimy, that the cell-wall may contain lignin, suberin, cutin, and pectin. Even in the general introduction it is evident that the mind of the writer is set on the "practical" economic part which is to come later. Thus (p. 25) he asserts as a general truth that many new varieties of fruit are bud varieties, that a certain branch on a tree is seen to possess peculiarities, and that it is taken off and propagated as a new variety. A more misleading statement, if intended to be of general application, it would be hard indeed to make. It would be interesting to know what variety of apple, pear, plum, currant, raspberry, or gooseberry is known to have arisen by bud variation!

Part ii., which consists of nearly 600 pages, contains much useful information with respect to the botany of cultivated plants. Members of the Gramineæ—cereal and other—are treated of at length and well, though from the teacher's point of view the work is too full for a text-book, and not full enough for a work of reference—for example, Mendelism is dealt with in half a page (p. 421), and, needless to say, the few words devoted to this all-important subject are not adequate to impress the student with the value of this method of genetical research.

The book contains much miscellaneous information which may perhaps interest the American student—that 44 million pounds of dried apples were produced in the United States in 1909, and that in 1915 more than 230 million bushels of apples were produced in that country; but, so far as may be discovered, nothing is said on the fascinating subject of pruning, which might, if scientifically treated, be the means of illustrating many important principles of physiology. Excellent as is much of the matter which it contains, this volume does not, in our opinion, give agricultural and horticultural teachers or students what they want—a new presentation of botanical principles based on the study of those plants among which they have to work. F. K.

OUR BOOKSHELF.

Practical Pyrometry: The Theory, Calibration, and Use of Instruments for the Measurement of High Temperatures. By E. S. Ferry, G. A. Shook, and J. R. Collins. Pp. vii+147. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 7*s.* net.

THE subject of pyrometry, so important nowadays in many industrial processes, is not as yet overburdened with literature of the text-book description. The present volume contains in a small compass most of the information required for an intelligent understanding of the principles and instructions as to the correct methods of manipulation of pyrometers, including the mathematical theory. Descriptions of historical interest only, with which such books are often burdened, are omitted, and the subject-matter is well chosen to give helpful instruction.

A separate chapter is devoted to each of the four principal types of pyrometer—namely, the resistance, thermo-electric, radiation, and optical pyrometers—with a preliminary chapter on the standard temperature scales. The best chapter in the book is that on optical pyrometry; the principles and construction of the various varieties are very clearly described and in a more thorough manner than is usual in text-books.

Exception might be taken to the omission of some of the simpler forms of pyrometer, such as the water pyrometer and the mercurial expansion and sentinel types. These appeal to many manufacturers, especially where great accuracy is not required, and guidance as to their use would therefore be acceptable.

The book is written for three classes of readers—college students, technically trained men who deal with processes requiring high-temperature measurements, and less trained observers who may make the measurements. To this end the more mathematical portions, such as Foote's mathematical investigation of cold junction error, and the more mathematical treatment of optical pyrometers, might with advantage have formed separate appendices for particular study, rendering the text clearer for the less technical reader.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Sea-fishery Investigations and the Balance of Life.

THE impression that Prof. McIntosh's address, published in NATURE of July 3 and 10, must leave upon the minds of readers unfamiliar with the history and progress of sea-fishery research must be that there has been a great deal of misdirected energy during the past fifteen or twenty years in the attempt to gain control of the output of the sea by the application of science to sea-fishery problems. If, as Prof. McIntosh still maintains, the prodigality and bounty of Nature mock all human efforts to modify the natural course of events in the sea for good or ill, it becomes surely a national duty to oppose all further applications for national expenditure upon sea-fishery investigations. As this, judging from his concluding paragraph, is not the aim which Prof. McIntosh has in view, it seems desirable to inquire a little more closely into the basis for his views, and to give at least the broad outlines of the superstructure of knowledge which has been reared above the basis of that fundamental work of his own, which has been a source of legitimate pride to himself as of appreciation by his successors and colleagues.

I think it will be conceded that the leading features of Prof. McIntosh's expressed views are, broadly speaking, as follows:—(1) The fecundity of sea-fishes is so great, and the ultimate food-supply for the fishes themselves is so completely independent of human influence that the idea of exterminating any species of food-fish—or even of seriously diminishing its total numbers—by intensive fishing is chimerical; (2) so long as man fails to make any serious impression upon the multitudes of young fishes, there is no need for anxiety; (3) no serious inroad upon the numbers of young fishes has hitherto been made; (4) therefore all is well, the fears of the pessimists are pointless, the claims of the optimists are established.

As Prof. McIntosh and "J. J." have been good enough to assign me the *rôle* of arch-pessimist, I may as well clear the ground by the remark that, when I approached the study of sea-fishery problems twenty years ago, the dominating question was: Is the practice of sea-fishing affecting the yield of the fishing grounds, or is it not? It was a case of *absolute stability* versus *depletion or impoverishment*. When, therefore, I find a tendency to re-define the question as being one of *slight deterioration* versus *extinction*, I demur. If I am to be dubbed a pessimist, that word must be understood to mean a person who, twenty years ago, urged that the "bottom fisheries" were not in a stable condition, not "holding their own," but showing clear signs of progressive impoverishment; and this was explained as meaning that "the rate at which sea (food) fishes multiply and grow, even in favourable seasons, is exceeded by the rate of capture" ("Impoverishment of the Sea," p. 8).

Passing on to points (2), (3) and (4), and restricting myself to plaice, as a test-case, the following quotations from Prof. McIntosh's recent articles are relevant:—"Plaice have been taken from the North Sea from time immemorial, and yet are *distributed* to-day over its entire area, while their tiny young swarm on every suitable sandy or muddy beach" (i., p. 356); "the removal of the larger fishes by intensive fishing is the rule, but the gaps thus made *are filled later* by the swarms of the smaller" (p. 357); "The idea that the North Sea can be fished out is chimerical, for even if all were gone over thrice or more frequently a year, such *could not produce depletion or exhaustion* of its fisheries—plaice included" (ii., p. 377); and, *à propos* of the International Council's findings with regard to the plaice question: "In other words, all that can be said is that the plaice are not less numerous, but . . . they are smaller—*a finding which leaves the plaice* in safety" (*l.c.*).

Putting these ideas together, it is plain that Prof. McIntosh regards the progressive diminution in the available numbers of the larger fish as negligible, and the continuous lowering of the average size as of no significance, so long as there are plenty of little fishes on the beaches. He ignores the evidence that the rate of growth of these little fishes and their rate of emigration to the offshore grounds no longer keep pace with the rate of capture. He treats the over-fishing problem as one of reproduction and numbers to the exclusion of rate of capture, rate of growth, and actual size attainable.

Apply this principle to agriculture, and consider what our meat-supply would be if the farmers killed all their cattle as calves except the minimum breeding stock necessary to keep up the number of—calves; or if, when thinning their turnips, they had regard, not to the production of the greatest possible weight, but merely to the production of that minimum number of mature plants which should give them seed sufficient for the next sowing!

Prof. McIntosh asks: "Where have the melancholy anticipations of the pessimists been demonstrated; where has the serious diminution of any food-fish occurred; where have the principles enunciated in 'The Resources of the Sea' been traversed by the International Fisheries Council?" (i., p. 355). The answer to the open mind is "on every page."

And what are the practical conclusions of "vigorous optimism"? "Let the authorities and the public place implicit confidence in the resources of the ocean and the ways of Nature therein" (ii., p. 378); "Be vigilant in guarding the national trust!" (*l.c.*). One may well ask of what comfort is the "marvellous plenitude and endurance of the sea-fishes" if they become measurably smaller year by year, or the "prodigality of Nature in their vast abundance and variety" if codlings are to represent cod, and plaice and lemon soles be replaced by dabs and long-roughs. And does "vigilance" consist in ignoring the plainest evidence accumulated by other people, while we sing hymns of praise to Pan or Poseidon? Let us turn now to the superstructure.

The qualitative basis of sea-fishery science, to which no one contributed more effectively than the veteran professor at St. Andrews, already shows the outlines of a quantitative structure upon it. Some of these outlines are still mere scaffolding, but the broad features of the building are discernible.

The idea of boundless prodigality, with its "chains of life" from diatoms to fishes, is not the end but the beginning. It is being steadily replaced by the conception of a balance or equilibrium of life, the two sides of which are the world of plant-life and small invertebrates on the one hand, and the world of fish-life on the other. The former has hitherto been beyond the influence of man, though subject to fluctuations in its total quantity in consequence of annual fluctuations of temperature, sunshine, and similar factors known to influence plant production, and, indirectly, the invertebrate and small vertebrate forms immediately dependent for subsistence upon the former. The fish-world, on the other hand, while undergoing annual and cyclical fluctuations in quantity depending on those of

the plant side, is also subject to the influence of man's fishing operations. These do not necessarily diminish the total yield of fish: on the contrary, they are probably powerless to affect the general balance, so far as total productivity is concerned. But the elimination of the larger fishes favours the survival of increasing numbers of the small, since the stock of food remains practically unchanged, while the enemies and competitors of the small are progressively reduced. It follows that the total *numbers* of the young of a given species may be appreciably *increased* as a result of fishing operations, through the progressive diminution of their infantile mortality.

Thus while the total quantity (weight) of the fish-side of the balance of life probably remains constant, its character may deteriorate sensibly. This deterioration is manifested not merely in the substitution of large numbers of small fish for smaller numbers of large fish of the same species, but also in the increasing survival of relatively small and worthless species which partly fill the gaps made by the progressive elimination of their larger competitors, *e.g.* dabs and long-rough dabs in lieu of plaice and lemon soles. Signs of this aspect of deterioration have been noticed in many areas, *e.g.* the Scottish bays, the Devon bays, Dogger Bank, etc.

In the case of plaice, the young of which are restricted to the coastal margins, while the adults range freely within 30 fathoms or so, the general tendency of intensive fishing is (*a*) to deplete the total density of plaice on the offshore grounds, and (*b*) to increase the number of small plaice along the shores. Thus large areas offshore have been opened up for the multiplication and growth of relatively worthless dabs, while the increasing accumulations of the young inshore have set up conditions of over-crowding, impoverished growth, and delayed emigration to the offshore waters.

The growth of a quantitative science of fish-life is thus tending to the production of a co-ordinated body of knowledge capable of deductive application to special practical and administrative problems. The continued growth of this knowledge is of the first importance for the development of the sea-fisheries. Without it administrators are at the mercy of every passing cry and excited agitation; with it, they will be enabled not merely to estimate more accurately the value of particular suggestions, but themselves to inaugurate a new era in the rational exploitation of the hitherto untamed forces of the sea. It should be needless to add that the value of particular investigations will have to be judged in future, not from the point of view of the mere resourcefulness of the sea, but from consideration of the extent to which they furnish means for intelligently controlling it. WALTER GARSTANG.

August 27.

"IMPOVERISHMENT" dies hard, and there is much glamour around it. My able friend, Prof. Garstang, commenced his campaign by showing that the great increase in the number of boats was accompanied by a diminished catch in each, and that, therefore, there were fewer fishes to catch than formerly, a view which did not survive publication. His modified "Balance of Life" will not rescue the Council from its responsibility on the question of "impoverishment."

The idea of gaining control of the "output" of the sea, as in a mine or quarry, is a novel way of dealing with the ponderous remit from the Government.

Prof. Garstang, like the Council, stakes his position on the plaice, an old tale, and one which is not proven. Large plaice do not frequent, as a rule, the areas of the smaller, and therefore the size is often a question of locality. For generations the same North Sea bay, as, for instance, St. Andrews, will produce the same sizes of plaice. Besides, adult plaice are not caught napping when they see a trawl coming: hence the well-known increase of the catch at night.

The "measurably smaller fishes year by year" probably refers to the boxes at Grimsby and other ports, an uncertain basis for generalisations. Again, are the herrings, gadoids, gurnards, mackerel, breams, wolf-fishes, and frog-fishes, the turbot, soles, and dabs, getting smaller year by year? It is a mistake to aver that dabs and long-rough dabs have anywhere usurped the areas of the "vanished" plaice.

No possible comparison can be made between human agencies in the hands of the farmer (*in re* cattle and turnips) and the ways of Nature in the sea. Such would not even fit the seals and the whales. The native farm-weeds, such as "quicken" and "knot-grass," are sufficient to illustrate Nature's powers.

The facts given in the "Resources of the Sea" (a second edition of which is ready for the press), stand in little need of a "superstructure or co-ordinated body of knowledge capable of deductive application to special administrative problems."

Truly, every encouragement is needed for scientific fisheries researches in marine laboratories and elsewhere. W. C. MCINTOSH.

DR. A. G. VERNON HARCOURT, F.R.S.

BY the death of A. G. Vernon Harcourt, on August 23, in his eighty-fifth year, there has passed away a chemical teacher endeared to many generations of Oxford students, a singularly skilful experimenter, and a pioneer in the new domain of physical chemistry. He was one of the first who planned experiments to enable him to follow the course of a chemical change, to measure the velocity of a reaction, and to study the conditions that determine it; he rebelled against the idea that chemists had to concern themselves only with the preparation of new substances and the elucidation of their properties—for him the interesting thing was *how* the change happened, not what was the result.

Starting with Brodie, first as his pupil and then as his assistant, Harcourt began his researches with the exact determination of the oxygen absorbed by the metals potassium and sodium—allowing air to enter slowly into a flask containing the pure liquid metal heated in an atmosphere of nitrogen. In this first paper one can see that it is the initiation and progress of the oxidation that interest him. "Soon after the dry air has begun to mix with the nitrogen, the grey film which covers the molten metal changes to a deep blue; the surface gradually becomes roughened by little wrinkles and projections, and a moment arrives when a single spluttering spark appears at one point and a dust of white oxide rises. . . . At the point where the spark appears the blue crust becomes white, and this change passes in a moment over its whole extent."

In 1859 Harcourt was elected Lee's reader in chemistry and a senior student of Christ Church, but it was not until some years after his appointment that he began his work in the Lee's laboratory. Meanwhile he had started those researches

on the rate of chemical change which—in conjunction with those of Berthelot in France and those of Guldberg in Norway—were to establish on a quantitative basis Berthollet's law of mass action. In the interpretation of his results Harcourt was associated with William Esson, whose special mission in Oxford seemed to be—as the writer knew him—to illuminate mathematically the obscure records of chemical velocities. Harcourt and Esson first studied the reaction between oxalic acid and potassium permanganate in acid solution. They found that the rate of change varied with the amount of manganous sulphate formed, and that the reaction was probably *nil* in the complete absence of manganous salt; but, once started, the velocity would increase to a maximum and then slack off—the curve representing the course of the change having a point of contrary flexure. They liken their curves to those obtained by Bunsen and Roscoe in the course of photochemical induction—thus suggesting that the "inductive period" in the union of hydrogen and chlorine was due to the action of another substance, a suggestion which finally was proved to be correct. Seeking for a less complicated reaction, Harcourt found that in dilute solutions hydrogen peroxide decomposed hydrogen iodide with velocities that could be easily followed, and the amount of change could be accurately ascertained. The method of carrying out the experiment in a stream of carbon dioxide, and the device by which the iodine liberated was reconverted into iodide by the successive additions of exactly equal drops of concentrated thiosulphate, show Harcourt at his best as an experimenter. The time-intervals between the successive appearances of the iodine proved that the velocity of the change varied directly with the quantities of each of the reacting substances—when the other conditions were kept constant. The rates found, however, do not prove that the change is necessarily a tri-molecular one as Harcourt supposed:—

$$H_2O_2 + 2HI = 2H_2O + I_2.$$

The change most probably takes place in two stages, each of which is di-molecular; but, one stage being much faster than the other, the observed rates follow the simple law.

In studying the effect of temperature on the rate of this reaction Harcourt and Esson arrived at a zero of chemical action in wonderful agreement with the absolute zero calculated from physical data.

Harcourt was so strongly convinced that chemical change followed mechanical laws that his laboratory became a centre where the experiments of Bunsen and his school on "chemical induction" and "sprungweise" explosions were repeated and criticised.

Harcourt's work as one of the metropolitan gas referees led him to take up the investigation of sulphur impurities in coal gas and to design a new standard of light—the Pentane standard. His method of converting carbon disulphide into the easily removed hydrogen sulphide has only recently been adopted on a large scale in the South Metropolitan Gas Works through the energy and skill of Dr. Carpenter, but its success seems assured. The 10-candle Pentane lamp is not only the official British standard, but also as a practical unit is not approached by the German amyl acetate lamp.

Few men have been so completely happy in their work, or lived so much in the lives of their students. The writer, whose good fortune it was to fall under his influence at Oxford, has to acknowledge that he owes his career to Harcourt's affectionate interest and to his example.

H. B. D.

DR. CHARLES A. MERCIER.

IT is not possible to give, in a few words, more than a mere indication of the value of the late Dr. Mercier's scientific work. With a rare, natural capacity for clear thinking, as well as for acquiring and retaining knowledge, he was a master of luminous and logical expression in speech and writing. These qualities inform all his many and various works, whether of purely scientific or mainly literary nature. Some of his books deal with the practical aspects of his professional speciality—insanity—such as the management of asylums, instructions to nurses, etc.; and others, like his essays on "Temperaments," treat of psychology and conduct for the general reader, as well as for the expert. But the main works, on which his reputation will rest, are scientific studies of the nervous system in health and disease, and include specially the whole subject of the causes, conditions, and expressions of mental action, normal and morbid. He was, as a student, much influenced by the writings of Herbert Spencer, and by the personal teaching of Dr. Hughlings Jackson, and their influence is seen in many of his works; but no less evident is his originality of thought, as especially seen in some of his more recent publications, which indicate strongly a marked change of attitude towards the so-called "Lamarckian" doctrine of biological evolution to which at first he strongly adhered. Like his two chief teachers, he made much use of the deductive step in reasoning, but he did not often fail to verify his conclusions by further evidence before adopting them. Judged from the scientific viewpoint, some of his most important works—*e.g.* on the "Nervous System and the Mind," on "Psychology, Normal and Morbid," and those dealing with insanity, may be considered as holding the highest rank among books of this kind, and as at least equal in value (though greatly differing in certain respects) to the now classical works of the late Dr Henry Maudsley, his illustrious senior and contemporary, on the "Physiology and Pathology of Mind," "From Organic to Human," "Body and Mind," etc.

Dr. Mercier's work, "The New Logic," has not pleased some professorial logicians, but, as a handbook of logical reasoning for scientific

students, it is of great value. Nor does it appear that his criticisms of the prevalent logic of the schools have been materially shaken, or that his acute comments on Mill's "Canons of Induction" have ever been refuted. His two important books on "Criminal Responsibility" and "Crime and Criminals" are written with much knowledge and careful thought, and form together one of the most notable contributions in the English language to the psychology of criminals and to the nearly allied subject of criminal jurisprudence.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

BEFORE the delivery of Sir Charles Parson's presidential address to the British Association last week, Sir Arthur Evans, the retiring president, announced that it was proposed to present an address to the King. The announcement was received with much satisfaction, and the address, which is as follows, was enthusiastically approved:—

Your Majesty,—On the occasion of the outbreak of the great war we, the members of the British Association for the Advancement of Science, at that time assembled in our eighty-fifth congress, gave an unanimous expression to our devoted loyalty to your Majesty's person, which your Majesty was graciously pleased to acknowledge.

To-day, once more assembled in our eighty-seventh congress, it is our heartfelt desire, on the victorious conclusion of the war and the formal proclamation of peace, to renew those assurances, and to express in more than a formal manner our high sense of the example of self-sacrificing devotion to the service of the country that has been so simply offered by your Majesty throughout this long and arduous struggle.

We are painfully aware, indeed, that, in spite of the decision in the field, the period of stress is by no means over. We cannot, from our special point of view, be blind to the extent to which the bitter emergencies of war-time have been prejudicial to those ideas and methods which it is our mission to promote. But in the not less arduous struggle that lies before us to regain the stable paths of peace we are heartened by the knowledge that the same wise and conciliating influence and high example that was of such sovran help to the British people in war-time will still be with them.

In vacating the presidential chair Sir Arthur Evans referred to the unprecedented period of three years during which he had occupied it, and he added:—

Let it at once be said that, though the public meetings of the association have been suspended, its organisation was constantly directed, at times in conjunction with other bodies like the Royal Society, towards rendering active assistance to the Government of our country in its hour of need. This has been the case, not only in fields of activity such as chemistry and engineering or the conservation of fuel and other economic objects—in matters, that is, that had a more direct bearing on the emergencies of the struggle—but I think I may say, to a greater or less degree, in every section of our body.

That expert assistance, as we know, has not always been welcomed by the powers-that-be. The dire necessities of war-time have led to rough-and-ready expedients altogether foreign to scientific method, and often conflicting with the most elementary knowledge. On every hand we see improvised controls as unscientific as they are arbitrary. We witness the constant overriding of expert experience by a new-fangled bureaucracy. At every turn we are met with a mischievous interference with natural laws and the perpetuation of uneconomic devices under conditions that no longer even palliate them. Though formal peace has been proclaimed, we are confronted by an evil heritage of war, and at no time has the British Association had more urgent occasion to inculcate those scientific methods and ideas by which alone the country can hope to regain its equilibrium.

The attendance at the meeting numbered nearly 1500, which is about the same as that at Manchester in 1915, and must be regarded as very satisfactory after so long an interval since the last assembly at Newcastle, where the attendance was only 826. A noteworthy point of the Bournemouth meeting was the large attendances in all the sections, several of which were uncomfortably filled on more than one occasion. This is a sign both of activity and interest, and it suggests that most of those who attended the meeting this year are concerned directly or indirectly with the advancement of science. In this, as in other respects, the meeting differed somewhat from those of former years, and marked a promising beginning of a new era.

A Committee appointed by the Council reported upon various matters relating to the working of the Association, and the report was adopted with slight changes by the General Committee. The fee for new life members is to be 15*l.* instead of 10*l.*, and for annual membership 1*l.* 10*s.* instead of 1*l.*, the right to receive the annual volume being included in both cases. The class of associateship has been abolished. The General Committee decided that after the Cardiff meeting next year, which will be held from a Tuesday to the following Saturday, the old plan of meeting from Wednesday to Wednesday shall be followed. When the Association was founded the meetings began on Wednesdays because the old stage coaches took about a couple of days to bring members to them from other towns, but though this condition no longer holds good there was a general feeling that the week-end break which a Wednesday to Wednesday meeting gives has advantages from the point of view of social intercourse, and that the Association could profitably revert to it. A preferable plan would be to consult the Local Committee as to which of the two periods—Tuesday to Saturday or Wednesday to Wednesday—would best suit the town and district in which a meeting was being arranged instead of laying down a hard-and-fast rule for all meetings.

The question of the position of the Association as regards grants for scientific research was raised in the report of the special Committee referred to, and was discussed at a meeting of the General Committee. During its existence the Association has voted from its funds more than 80,000*l.* to its

research committees, and it is scarcely too much to say that every pound of this large sum has been well expended. The grants are allocated each year by the Committee of Recommendations, which usually consists of the presidents and recorders of the various sections, together with the general officers. Every research committee has thus to present its case for support to an expert body of adjudicators which frequently devotes several hours to dividing up the 1000*l.* or so available at the end of each meeting into grants of 5*l.* and upwards for research committees put forward by the sectional committees. It has been suggested that in view of other claims upon the revenue of the Association the funds devoted to purposes connected with research should be more closely limited to incidental expenses inasmuch as other funds are now available to assist research itself. However this may be, the principle by which men of science themselves allocate grants in aid of research, as they do at a British Association meeting, is generally accepted to be the best, whether the funds are their own contributions or are entrusted to them for research purposes. The Association is, therefore, to continue the present system by which grants are allocated by the Committee of Recommendations, but the list of grants so made is afterwards to be submitted to the Department of Scientific and Industrial Research, which will select subjects it can support, and will relieve the Association of the financial obligations relating to such subjects.

It remains to be seen whether this method will provide the most effective link between the Department and the Association. A joint Committee, consisting of four members appointed by the General Committee, and four by the Council, is to inquire into the whole matter of the existing provision of grants in aid of scientific research and the organisation of research. No change in the Association's method is contemplated, but there is a feeling that a useful purpose would be served by a survey of what is now being done to promote research through grants in aid by various societies and other bodies, the methods by which such grants are allocated, and the conditions to be fulfilled by the recipients.

Next year's meeting is to be held at Cardiff under the presidency of Prof. W. A. Herdman, who has been succeeded as general secretary by Prof. J. L. Myres. An invitation to meet in Edinburgh in 1921 was unanimously accepted by the General Committee. The new members of the Council of the Association are: Prof. A. Fowler, Dr. E. H. Griffiths, Prof. A. W. Kirkaldy, and Dr. W. H. R. Rivers.

SECTION A.

MATHEMATICAL AND PHYSICAL SCIENCE.

OPENING ADDRESS BY PROF. A. GRAY, M.A., LL.D., F.R.S., PRESIDENT OF THE SECTION.

I HAVE devoted some little time to the perusal of the addresses of my predecessors in this chair. These have a wide range. They include valuable philosophical discussions of the nature of scientific knowledge and expositions of scientific method, as well as highly instructive *résumés* and appreciations of the progress of mathematics and physics. But as this is the first meeting of the British Association since the conclusion of peace, I have decided to disregard in the main these precedents, and to endeavour to point out, in the first place, some of the lessons which the war has, or ought to have, taught our country and those who direct its policy, and in particular ourselves, whose vocation it is to cultivate and to teach mathematical and physical science.

Before proceeding with this task I must refer to the loss which physical science and the British Association have suffered this year through the deaths of Prof. Carey Foster and Lord Rayleigh. Both these great physicists were regular in attendance at the meetings of the association, and they will be greatly missed.

What Carey Foster was as a man of science, as a teacher, and as a friend of all students of physics has been worthily set forth in the columns of NATURE with all the knowledge and affectionate reverence of one who was at once his pupil and his fellow-worker at University College. To that eloquent tribute I will not, though I knew Carey Foster well, venture to add a word.

It is not for me to appraise here the work of Lord Rayleigh. But I may say that for something like half a century his name has stood, not only for things that are great in physical discovery, but for sanity of judgment and clarity, elegance, and soundness of treatment of outstanding and difficult problems of mathematical physics. His researches, too, in experimental science have been fruitful in results of the utmost importance in chemistry as well as in physics. With him there was no shirking of the toil of monotonous and systematic observation from day to day in the pursuit of the greatest attainable accuracy; take, for example, his work on electrical units. But his influence on applied mathematics has also been enormous, and places him for all time in the foremost rank of the great physical mathematicians, at the head of which stands Isaac Newton. One has only to read his treatise on "The Theory of Sound" and his papers on optics and wave theory to find some of the most striking examples in all scientific literature of the working of a mind, not only of the first order of originality, but imbued with a feeling for symmetry of form and clearness of exposition.

Lord Rayleigh's genius was, it seems to me, essentially intuitive and practical. Though he was not given to any striving after the utmost rigidity of formal proof—which, as he himself remarked, might not be more but less demonstrative to the physicist than physical reasons—no man made fewer mistakes. He is gone, but he has left an inspiring example to his order and to his countrymen of a long life consecrated to the object for which the Royal Society, of which he had been the honoured president, was founded: the furtherance of natural knowledge.

The part which physical science has played in the conduct of the war on our side has been an important one, but it has by no means been so decisive as it might and ought to have been. And here lie the lessons which I think we can draw from the terrible events which have taken place. Some few people, mostly hostile to or jealous of science, whose vision of facts and tendencies seems to me to be hopelessly obscured by prejudice, would try to impose on the advance of natural knowledge and the supposed increased influence of scientific ideas on the minds of men, or, perhaps more precisely, on the diminution of the study of the so-called humanities, the sole or the main responsibility for the outbreak of war.

It seems to me that a good many people allow themselves to be misled by a name. The name "humanity" is given in the Scottish universities to the department of the Latin language and literature, and in a wider usage the study of Latin and Greek is referred to as that of *litterae humaniores*. But I am not aware that there is any more humanity, in the common acceptance of the term, about these studies than there is in many others. And experience has shown that the assertion that these studies have a special refining influence, while the pursuit of science has a brutalising tendency, is based on ignorance and partiality. The truth is that the man who knows nothing of science, and he who has neglected the study of letters, are both imperfectly educated.

Well, the accusation I refer to may be dismissed without argument. This is certainly not the time or the place for a discussion of the causes of the war, or of the ethics of the extraordinary methods introduced into warfare by our enemies. But one thing I will say in this connection. Even poison gas is innocent in itself, and it occurs as a product in perfectly indispensable and eminently useful chemical processes. The extraordinary potency of scientific knowledge for the good of civilised mankind is frequently conjoined with a potency for evil; but the responsibility for an inhuman use of it does not lie with the scientific investigator. The guilt lies at the door of the High Command, of the high and mighty persons, themselves in feeling and temper utterly unscientific, who approved and directed the employment of methods of attack which destroyed the wounded and helpless, and wrecked for ever the health of many of those who emerged alive from the inferno.

As regards the help which British science was able to render in the defence against the German attack and the operations which followed when the fortune of war changed so dramatically, and the enemy was driven back towards the chain of fastnesses from behind which he originally emerged, one or two obvious reflections must have occurred to everyone. In one form or another these have been referred to by various writers, but I may recall one or two of them; for as a people we are incorrigibly forgetful, and appear to be almost incapable of profiting from experience, which, according to the Latin proverb, teaches even fools.

Nearly twenty years ago the urgent necessity for the reorganisation of our military machinery had been, in the view of civilians at least, who had to bear the cost of the war in South Africa, demonstrated *ad nauseam*, but nothing of real importance in the way of reforming the War Office seems to have been done. The shocks we had received were forgotten, and soon the nation returned to its insular complacency, the old party cries resounded in the market-place, the hacks of party politics again resumed their occupation of camouflage and hoodwinking, and the country drifted on towards its fate.

All this time an enormously powerful war machine was being built up on the Continent, and its different parts tested so far as that could be done without actual warfare. The real object of these preparations was carefully veiled by an appearance of frankness and professions of goodwill, though it was revealed every now and then by the indiscretions of the German military caste. To these indications and to others the country, ostrich-like, closed its eyes.

Now it is often alleged that men engrossed in the pursuit of science are unbusinesslike, but I think that if there had been any truly scientific element in the *personnel* of the Government (there never is by any chance), attention would have been directed at a much earlier period to our hopeless state of unpreparedness for the storm which was gradually gathering against us on the other side of the German Ocean. In discussions of our unpreparedness the emphasis has been placed on our lack of arms and munitions. But important as these are, the entire absence of a scientific organisation to guide us in the exigencies of a defensive war with the most scientific and most military nation of Europe was even more serious.

It is this deficiency in our organisation—a deficiency the avoidance of which would have had no provocative effect whatever—which concerns us here very specially. It is, moreover, a deficiency which, in spite of the lessons they have received, has, I fear, not yet been brought home to our military chiefs. When war broke out nothing had been done to ensure the utilisation for special service, in the multitude of scientific operations which war as carried on by the German armies involved, of the great number of well-trained young scientific men available in the country. The one single idea of our mobilisers was to send men to the trenches to kill Germans, and for this simple duty all except certain munition workers and men in the public services were summoned to the Army. Some modifications were made afterwards, but I am speaking of the failure of prevision at the outset. The need of men for special service, the inevitable expansion of the Navy for patrol and other purposes and the like, were, if they were thought of at all, put aside, without regard to the difficulties which would inevitably arise if these matters were delayed. Even how the new soldiers were to be trained, almost without rifles or machine-guns, to meet the Germans in the field nobody knew. And I for one believe that but for the vigour and energy of Lord Kitchener, and the almost too late expression of conviction of our danger, and consequent action, by one outstanding politician, all would have been lost. We worried through, but at a loss of life and treasure from which it will take us long to recover, and which I could wish seemed to weigh more heavily on the minds and consciences of politicians.

The Germans, I believe, had a complete record, not only of all their men fitted only for the rank-and-file, but also of all who had been trained to observe and measure. For the use of even the very simplest apparatus of observation a certain expertness in reading graduated scales, and generally a certain amount of trained intelligence, is required. For this the laboratories of Germany amply provided, and the provision had its place in the enemy's mobilisation. Our people apparently did not even know that such a need existed or might arise.

In a letter which I sent to the council of the Royal Society at the end of 1915 I ventured to propose that the Royal Society might set on foot an organisation of some such character as the following:—First, a central committee should be established, in some degree representative of the different centres of scientific teaching and work in pure and applied science. Then this committee should nominate representatives at each centre, at least one at each university or college, and one at the headquarters of each local society, such, for example, as the Institution of Engineers and Shipbuilders of Scotland and the similar society which represents the North-East of England and has its offices at Newcastle-upon-Tyne. This arrangement, it was hoped, would enable the central committee to obtain readily information as to what men were available, and would therefore do something to bring the schools of science, and all the great workshops and laboratories of applied science, into co-operation. Thus could be formed at once a list of men available for particular posts, for the task of solving the problems that were certain to arise

from day to day, and for the special corps which it was soon, if dimly, perceived were a necessity. Some such linking-up of London with the provinces is really indispensable. The districts of, for example, the Tyne and the Clyde are too much ignored in almost all Government action of a general kind.

My letter was printed and sent out to some prominent men, by whom its proposals were highly approved. A conference on its subject was held in London, and two special committees were appointed. I was a member of one of these, the principal duty of which was to provide scientific men for special service. It included representatives of the various great departments actively engaged in the conduct of the war. For some reason or other, which I never learned, the committee after a week or two ceased to be called, and I believe that little was done in comparison with what might have been accomplished. It was certainly not because such a committee would not work. Everybody was most willing, with proper notice, to attend such meetings as were involved, and to take any amount of personal trouble; moreover, the scheme was such as to provide that there should always be a nucleus of members in London to consult and act in any emergency.

I may briefly refer to one or two examples of the chaos which prevailed and the attempts that were made to cope with it. Very soon after the formation of the first Kitchener Army the organisation of the different corps apparently became a source of anxiety to the War Office. It began to be seen that officers in sufficient numbers could not possibly be obtained by the usual channels, so the expedient (a poor one by itself) was hit upon of placing the nominations to commissions in one at least of the two great scientific corps of the Army—the Royal Engineers—in the hands of the presidents of certain technical institutions which have their headquarters in London. These gentlemen, with the help of the official secretaries, no doubt did the best they could, but a very regrettable, though perfectly natural, amount of strong feeling was evoked among the young scientifically educated men in the provinces, who were keenly anxious to join this corps. The Engineers, I may scarcely say, is no refuge for men who are in the least concerned about their personal safety, for the percentage of casualties among engineers on active service was notably higher than in the regiments of the line. Over and over again young engineers came to me and complained that under the arrangements made they had no chance of obtaining commissions or of qualifying as cadets, and begged me to write to the authorities. Of course, young graduate engineers do not, as a rule, join societies such as the Institutions of Civil, Mechanical, or Electrical Engineers until they have made their way to some little extent and begun to earn a little money.

The procedure I have indicated had in time to be relaxed, but such a central committee as I suggested, with antennæ stretching out to the educational and technical centres of the country, would, I am sure, have recruited the Engineers quickly with the best possible material for officers to be found in the country, to the satisfaction of all concerned. It may be said that full information regarding every man in the country was in the hands of the authorities. In a sense, this was true; the information existed in millions of returns and thousands of pigeon-holes, but no attempt was made, or could be made, by office staffs in London, enormous as these quickly became, to digest and utilise it.

A large number of engineers and physicists and many others of mechanical skill and aptitudes found congenial occupation in the Royal Naval Air Service and the Royal Flying Corps; but even there, where things could be better done, since a new force had to be brought into existence, arrangements were to a considerable extent haphazard and ill thought out. Excellent self-sacrificing service was rendered by many who risked and gave their lives, and of what was done we may well be proud. But from a scientific point of view there is room for great improvement. The hasty and ill-considered—as I think—amalgamation of these two branches of the Air Service, in which naval traditions were sacrificed to those of the War Office, which deserved no such deference, will certainly have to be undone in the near future or very greatly transformed. To anyone who considers the possibilities and probabilities of warfare in the future, it appears clear that this country will have to depend more and more upon its Navy, and that an Air Service Corps will be the companion of every division of our Fleet, with landings on the warships. Thus a new and highly scientific Service, which will have to be to a great extent naval, will be brought into existence.

Well, then, to return for a moment to my proposal to the Royal Society, why should the organisation which I suggested in 1915 not be established now? I wish all success to the League of Nations, but we shall prove ourselves even greater fools than we have been in the past if we do not use all possible means to prepare ourselves against eventualities. One attempt by our enemies outside our own borders to hold us to ransom has failed. Can we be so sure that no other attempt will ever be made, or that no *casus belli* between ourselves and another great nation will ever arise? This, I notice, is beginning to be assumed even in the midst of the welter of confusion and unrest that exists, and, among others, by just the very people who used to teach that the possibility of war was a great illusion.

The formation of a record of scientific graduates for special service ought not to be difficult. The material already in great measure exists. Each university and college has its roll of graduates or diploma-holders, and with slightly more detailed entries these rolls would give the record. Each graduate of a university is kept track of through the necessity for keeping the electoral roll up-to-date, and it ought to be possible to devise a means of maintaining touch with the diploma-holder. If each university or college were a local centre of the central committee, the making of the roll of graduates would be achieved at the different local headquarters, and would be a valuable supplement to the O.T.C. work now undertaken so willingly and done so well. The Government machinery which manages the O.T.C. movement might control the keeping of the register which I have suggested.

I turn now to another side of scientific work during the war. It was my lot to serve for nearly three years on the Inventions Panel of the Ministry of Munitions, and as the result of that experience I venture to make some observations on the utilisation of scientific knowledge and genius in the production of inventions useful for the public service. We had an enormous multitude of inventions to consider, and the Panel was divided into Committees for this purpose. For each invention or proposal a file or *dossier* was prepared and most carefully kept. There were also present at the meetings of the Panel very efficient officers representing different branches of the Service. Everything received careful attention, and for the ability and fairness with which the initial examination was made by the corps of examiners, and the *précis* of the invention presented, I have great admiration. Much has been said about the inefficiency and the mistakes of

various Government Departments during the war. The Ministry of Munitions Inventions Department was, so far as I could see, eminently well managed.

Many of the so-called inventions were not inventions at all. Some were not at all new; in other cases an idea only was mooted. Could so-and-so not be done? and so on, and the Department was supposed to be grateful for the idea, and to do the rest, besides rewarding the proposer. A favourite notion, which illustrates the diffusion of scientific knowledge among different classes of people, was that of taking a magnet—any magnet—up on an aeroplane, and using it to attract Zeppelins and other aircraft. Others suggested electromagnets fed by machines which would have involved carrying into the air on an aeroplane a fully equipped power-house! Another favourite notion, inspired, no doubt, by a certain sensational type of article in the fiction magazines, was that of rays charged in some way with electricity, or some other mysterious agency, and therefore intensely destructive.

But there was a residuum of valuable inventions which fully justified the existence of the Department. These were recommended for further consideration by the various departments of the Services or by General Headquarters. It by no means followed that all that came to this stage received careful further consideration. Everybody was very hard worked, and many were overdriven. And it was by no means certain that when important approved appliances were sent to G.H.Q. a thoroughly well-informed and capable officer would in all cases have the duty of explaining and showing their action. The absence of such an officer, I am sure, often resulted in delay and serious error, and, I fear, also in the rejection of what was in itself exceedingly good, but was not understood. People who knew nothing about the matter took charge, and ordered things to be done which brought disaster to the apparatus. I know of one very important machine which was ruined, with much resulting delay. A brigadier or major-general with a confidence born of blank ignorance ordered a motor-generator to be put on town electric mains, and, of course, burnt it out.

Then, again, we were told that G.H.Q. did not want this or that, and here, as in all human affairs, mental inertia certainly played a considerable part. The willingness, however, of some Departments to adopt at once a device captured from the enemy was pathetic. Often quite clumsy and relatively inferior contrivances were adopted in the midst of hesitation about our own. Anything German of this sort some people assumed must be good—a foolish idea, the result of want of confidence, often well founded, I am afraid, in their own judgment. It is legitimate to copy from the enemy, and in several important things we have not been slow to do so.

The delays that occurred were to some of us at home, who were anxiously dealing with all kinds of contrivances, exceedingly exasperating. Some were undoubtedly unavoidable, but others were, as I have indicated, far otherwise. Deficiency in scientific education was the cause. It is to enforce the need for such education that I refer to such matters at all. The "playing fields of Eton" are all very well. I for one do not scoff at what the old saying stands for, but scientific laboratories and good intelligent work in them are indispensable. A man who directs in whole or in part a great machine must know something of its structure and capabilities.

I feel bound to allude to another aspect of the inventions business which, to my mind, was very serious. In doing so, however, I wish it to be clearly understood that I am criticising a system, and in no way here referring to particular individuals concerned in its administration. Various inventions which had passed satisfactorily the first examinations by responsible judges were submitted to technical departments at home to be subjected to practical tests. These inventions were frequently proposed solutions of problems on which technical officers, of the departments required to conduct the tests, had long been engaged. It was natural, indeed inevitable, that some of these officers should have come to regard the solving of these problems as their own special job, and so did not much welcome the coming of the outside inventor. Then, no doubt, they often felt that they were just on the point of arriving at a solution—a feeling that certainly could not facilitate the avoidance of delay. It was manifestly most unfair to ask them to judge the work of the outside inventor, or to place in their hands details of his proposals, for exactly the same reason which in civil life restrains a man from acting as a juror in a case in which he is personally interested. Nobody of good sense feels offended when attention is directed to such a rule in practice.

Thus I have no hesitation in expressing the opinion that a testing board of practical, well-qualified physicists and other experts, with a properly qualified staff, should be formed for the purpose of carrying out all tests of inventions. No insuperable difficulty would, I believe, be experienced in forming such a board. It should be formed carefully, not by more or less casual nomination of one another by a few persons. Expert knowledge of a subject should be a necessary qualification; the so-called "open mind" of the much-lauded but untrained practical man is not worth having. But on that board neither inside nor outside inventors of the same kind of appliances should have any place, though, of course, consultation with the author of an invention under test would be absolutely necessary. Also those actually carrying out the tests and those collating the results should not be men in any way in the employment of, or under the supervision of, inventors, whether "outside" or "inside." It is imperative in the interests of the country that delay in such matters should be avoided, and that all such work should be done without fear or favour.

The value of university and college men trained in science has been thoroughly proved in the Artillery, the Engineers, and in their offshoots, the Special Sound-ranging and Survey Corps, though its recognition by the authorities of Whitehall has been scanty and grudging. Some of the old-fashioned generals and staff officers could not be got to see the use of men who had not been trained to field exercises by a long course of drill. What is the good of officers, they said, who are not skilled leaders of men? This is the old crude idea again of destroying Germans with rifles, bayonets, and hand-grenades. The falsity of these antiquated notions has now, I believe, been amply demonstrated.

The objection to these men, however, lies a good deal deeper. Even those scientifically educated officers who came into the new armies when they were formed, and were trained by the service of years of warfare superadded to the initial course of drill, have been demobilised in a nearly wholesale manner, without the least regard to even very exceptional qualifications. Many of these were, it seems to me, the very men who ought, above all, to have been retained in the Service. Now (though, as I write, improved regulations are being issued) they are to a great extent to be replaced by the public school-*cum*-Sandhurst young gentlemen, who, it appears, are the "pukka" officers *par excellence*.

The old system of the rule of politician chiefs whose only or main function is to sign the edicts of heads of departments seems to have returned in full force, and the coming of the cleansing Hercules that many people desire for the War Office does not seem to be within the bounds of possibility.

The real cause of the prevailing neglect of science, with all its pernicious results, is that almost all our political leaders have received the most favoured and fashionable form of public school education, and are without any scientific education. An education in classics and dialectics, the education of a lawyer, may be a good thing—for lawyers; though even that is doubtful. For the training of men who are to govern a State the very existence of which depends on applications of science, and on the proper utilisation of available stores of energy, it is ludicrously unsuitable. We hear of the judicial frame of mind which lawyers bring to the discussion of matters of high policy, but in the majority of scientific cases it is the open mind of crass ignorance. The result is lamentable; I myself heard a very eminent counsel declare in a case of some importance, involving practical applications of science, that one of Newton's laws of motion was that "friction is the cause of oscillations"! And the helplessness of some eminent counsel and judges in patent cases is a byword.

As things are, eminence in science is no qualification; it would even seem to be a positive disqualification for any share in the conduct of the affairs of this great industrial country. The scientific sides of public questions are ignored—nay, in many cases our rulers are unconscious of their existence. Recently in a discussion on the Forestry Bill in the House of Lords a member of that illustrious body made the foolish assertion that forestry had nothing to do with science; all that was needed was to dig holes and stick young trees into them. Could fatuity go further? This hereditary legislator who, as things are, has it in his power to manage, or mismanage, the conversion into available energy of the radiation beneficently showered on a certain area (his area) of this country of ours does not seem to be aware that the growing of trees is a highly scientific industry; that there are habits and diseases of trees which have been profoundly studied; that, in short, the whole subject of sylviculture bristles with scientific problems, the solutions of which have by patient labour been to a considerable extent obtained.

Take also the case of the dyes industries. The publicists and the good business men—the supermen of the present age—who wish to control and foster an industry which owes its very existence to an English chemist, refuse to have on the committee which is to manage this important affair any man of scientific eminence, and no remonstrance has any effect. These great business men are, as a rule, not scientific at all. They are all very well for finance; in other respects their businesses are run by their works-managers, and, in general, they are not remarkable for paying handsomely their scientific assistants.

I myself once heard it suggested by an eminent statesman that an electrical efficiency of 98 per cent. might by the progress of electrical science be increased fourfold. This, I am afraid, is more or less typical of the highly educated classical man's appreciation of the law of conservation of energy; and he is—save the mark!—to be our Minister or Proconsul and the conservator of our national resources. It is not surprising, therefore, that in connection with a subject which for several weeks occupied a great space in the newspapers, and is now agitating a large section of the community, the nationalisation of our coal-mines, there was not a single word, except perhaps a casual vague reference in the report of the chairman, to the question which is intimately bound up with any solution of the problem which statesmen may adopt—I mean the question of the economic utilisation, in the interests of the country at large, of this great inheritance which Nature has bestowed upon us. In short, are Tom, Dick, and Harry, if we may so refer to noble and other coalowners, and to our masters the miners, to remain free to waste or to conserve at their own sweet will, or to exploit as they please, this necessity of the country's existence?

The fact is that until scientific education has gone forward far beyond the point it has yet reached, until it has become a living force in the world of politics and statesmanship, we shall scarcely escape the ruin of our country. The business men will not save us; as has been said with much truth, the products of modern business methods are, to a great extent, slums and millionaires. It lies to a great extent with scientific men themselves to see that reform is forthcoming; and more power to the British Science Guild and to any other agency which can help to bring about this much-needed result.

While scientifically educated men, whether doing special work or acting as officers, have been held of far slighter account in the Services than they ought to have been, for physicists as such there has been little or no recognition, except, I believe, when they happened to be ranked as research chemists! How did this happen? Why, the various trades asserted themselves, and the result was a sufficiently long list of "reserved occupations"—a list remarkable both for its inclusions and for its exclusions. There was, for example, a class of "opticians," many of whom have no knowledge of optics worth mentioning. They are merely traders. One of these, for example, the proprietor of a business, made a plaintive appeal to myself as to how he could determine the magnifying powers of certain field-glasses which he wished the Ministry of Munitions to purchase. But for a young scientific man, even if he were an eminent authority on theoretical and practical optics, but who was not in the trade, there was no place.

Research chemists received their recognition in consequence of the existence of the Institute of Chemistry. I am extremely glad to find that something is now being done to found an Institute of Physics. I hope this movement will be successful, and that it will be thoroughly practical and efficient. I hope its president and council, its members and its associates, will be jealous for science, and especially for physics. It ought to be a thoroughly hard-working body, without any frills, destitute of work value. They have an example in the General Medical Council, which has so effectively cared for the interests of the medical profession.

I am glad that something is being done at last for the organisation of scientific research. This movement has started well in several, if not in all, respects, and I wish it all success. There are, however, one or two dangers to be avoided, and I am not sure—I may be much too timid and suspicious—that they are fully recognised, and that the result will not be too much of a bureaucracy. Somehow or other I am reminded by the papers I have seen of the remark of a poor man who, asking charity of someone in Glasgow, was referred to the Charity Organisation Society of that city. "No, thank you," he said; "there is a good deal more organisation than charity about that institution." So I hope that in the movement on foot the organisation will not be more prominent than the science, and the organisers than the scientific workers.

There is, to my mind, too much centralisation aimed at. Everything is to be done from London;

a body sitting there is to decide the subjects of research and to allocate the grants. There may be a good deal to be said for that in the case of funds obtained in London. But apparently already existing local incentives to research work are to be transferred to London. The Carnegie Trust for the Universities of Scotland, soon after its work began, inaugurated a scheme for research work in connection with these universities. The beneficiaries of the Trust, it is well known, must be students of Scottish nationality. The action of the Trust has been most excellent, and much good work has been done. Now, so far as chemistry and physics are concerned, it has been proposed, if not decided, to hand over to the organisation in London the making of the awards, a process of centralisation that will probably not end with these subjects. I venture to protest against any such proceeding. The more incentives and endowments of research that exist and are administered in the provinces the better. Moreover, this is a benefaction to Scottish students which ought not to be withdrawn and merged in any provision made for the whole country, and administered in London by a bureau which may know little of the Scottish universities or of Scottish students. The bureau might, with equal justice or injustice, be given command of the special research scholarships of all the universities both in England and Scotland, and administer them in the name of the fetish of unification of effort. I do not know, but can imagine, what Oxford and Cambridge and Manchester and Liverpool would say to that. But even Scotland, where of course we know little or nothing about education of any kind, may also have something to say before this ultra-centralisation becomes an accomplished fact.

There is, it seems to me, another danger to be avoided besides that of undue centralisation in London. In most of the statements I have seen regarding the promotion of research work, the emphasis seems to be on industrial research—that is, in applied science. This kind of research includes the investigation of physical and chemical products of various kinds which may be used in arts and manufactures, and its deliberate organised promotion ought to be a commercial affair. I observed, by the way, with some amusement, that according to the proposals of one committee for applied science, which is prepared to give grants and premiums for researches and results, the professor or head of a department, from whom will generally come what are most important, the ideas, is to have no payment. He is supposed to be so well paid by the institution he belongs to as to require no remuneration for his supervision of the committee's researches. And the results are to be the sole property of the committee!

There is in this delightfully calm proposal at least a suggestion of compulsion and of interference with institutions and their staffs which ought to be well examined. Also some light is thrown on the ideas of such people as managing directors of limited liability companies, who are members of such a committee, as to what might reasonably be expected of men of high attainments and skill whose emoluments taken all round are, on the whole, miserably insufficient.

I think that it is in danger of being forgotten that, after all, pure science is by far the most important thing. Most of the great applications of science have been the products of discoveries which were made without any notion of such an outcome. Witness the tremendous series of results in electricity of which the beginning was Faraday's and Henry's researches on induction of currents, and the conclusion was the work of Hertz on electric waves. From the first came the production and transmission of power by electricity; from the last the world has received the gift of wireless telegraphy. I am not at all sure whether the great men who worked in the sixty or seventy years which I have indicated would have always received grants for proposed researches, which to many of the good business directors and other supermen serving on a great bureau of investigation, had such then existed, would have appeared fantastic and visionary. In research, in pure science at least, control will inevitably defeat itself. The scientific discoverer scarcely knows whither he is being led; by a path he knows not he comes to his own. He should be free as the wind. But I must not be misunderstood. Most certainly it is right to encourage research in applied science by all available and legitimate means. But beware of attempting to control or "capture" the laboratories of pure science in the universities and colleges of the country. Let there be also ample provision for the pursuit of science for its own sake; the return will, in the future as in the past, surpass all expectation.

I had intended to say something about scientific education as exemplified by the teaching of physics. I have left myself little time or space for this. I cannot quite pass the matter over, but I shall compress my remarks. In the first place, I regard dynamics, especially rotational dynamics, as the foundation of all physics, and it is axiomatic that the foundation of a great structure should be soundly and solidly laid. The implications of dynamics are at present undergoing a very strict and searching examination, and now we may say that a step in advance has been taken from the Newtonian point of view, and that a new and important development of dynamics has come into being. I refer, of course, to the new theories of relativity which are now attracting so much attention. I hope to learn from the discussions, which we may possibly have, something of the latest ideas on this very fundamental subject of research. It is a matter for congratulation that so many excellent accounts of relativity are now available in English. Some earlier discussions are so very general in their mathematical treatment and notation as to be exceedingly difficult to master completely. I have attacked Minkowski's paper more than once, but have felt repelled, not by the difficulties of his analysis, but by that of marshalling and keeping track of all his results. Einstein's papers I have not yet been able to obtain. Hence it is a source of gratification to have Prof. Eddington's interesting report to the Physical Society and the other excellent treatises which we have in English. But continual thought and envisaging of the subject is still required to give anything approaching to instinctive appreciation such as we have in ordinary Newtonian dynamics. I venture to say that the subject is pre-eminently one for physicists and physical mathematicians. In some ways the new ideas bring us back to Newton's point of view as regards so-called absolute rotation—a subject on which I have never thought that discussions of the foundations of dynamics had said absolutely the last word. I, for one, still cling to the æther, and am strongly of opinion that the whole subject of æther and matter and electrons require much more complete physical treatment than it has yet received from relativists.

The better the student of physics is grounded in the older dynamics, and especially in the dynamics of rotation, the sooner will he be able to place himself at the new point of view, and the sooner will his way of looking at things begin to become instructive.

With regard to the study of physics in our universities and colleges, I had written a good deal. I have put that aside for the present, and will content myself with only a few general observations. First, then,

it would, I think, be conducive to progress if it were more generally recognised that dynamics is a physical subject, and only secondarily a mathematical one. Its study should be carried on in the departments of physics, not in those of mathematics or in separate departments of applied mathematics. It is, or ought to be, essentially a subject of the physical lecture-room and the physical laboratory. The student should be able to handle rotating bodies, to observe and test the laws of precession and nutation—to work himself, in a word, into an instinctive appreciation of at least the simpler results of rotational theory. He should learn to think in vectors, without necessarily referring either to Hamilton or to Grassmann. Some people appear to censure the use of vector ideas without the introduction at the same time of some form of vector notation. I do not feel drawn to any system of vectors in particular—all have their good points, and in some ways for three-dimensional work the quaternion analysis is very attractive—but vector *ideas* are of the very utmost importance.

Hence I deprecate the teaching, however elementary, which as a beginning contents itself with rectilineal motion. The true meaning of rate of change of a directed quantity, even of velocity and acceleration, is missed, and instead of having laid a foundation for further progress the teacher, when he desires to go beyond the mere elements, has practically to relay his foundations; has, in fact, to extract imperfect ideas from his pupils' minds and substitute new ones, with the result that a great deal of avoidable perplexity and vexation is produced. The consideration of the manner of growth of vectors—the resultant vector or it may be component vectors, according to convenience—is the whole affair. As an illustration of what I mean, take this:—A vector quantity has a certain direction, and also a magnitude L. It is turning in a certain plane with angular speed ω. This turning causes a rate of production of the vector quantity about a line in that plane and perpendicular to the former, and towards which the former is turning, of amount $L\omega$. Thus a particle moving in a curve with speed v has momentum mv forwards along the tangent at the position of the particle. The vector is turning towards the principal radius (length R) of curvature at the point at rate v/R. Hence towards the centre of curvature momentum is growing up at time-rate mv^2/R.

Dealt with in this way, with angular momentum instead of simple momentum, the motions of the principal axes of a rigid body give the equations of Euler instantly and intuitively, and all the mind-stupefying notions of centrifugal couples and the like are swept away.

With regard to mathematics, the more the physicist knows the better, and he should continually add to his store by making each physical subject he takes up a starting-point for further acquisition. Some very philistine notions as to mathematics prevail, and are very mischievous. For example, I once heard an eminent practical engineer declare that all the calculus an engineering student requires could be learned in an hour or two. This is simply not true, nor is it true, as some exponents of ultra-simplicity seem to suggest, that the professional mathematical teacher wilfully makes his subject difficult in order to preserve its esoteric character. Like the engineer or physicist himself, he is not always so simple as he might be; but the plain truth is that no good, progressive mathematical study can be carried out without hard and continued application of the mind of the student to the subject. And why should he depend on the mathematical reader? Let him be his own teacher! There are plenty of excellent books. If he has a determination to help himself he will, if he makes a practice of reserving difficulties and returning to them, find them vanish from his path.

As I have said, I am specially interested in rotational dynamics. In the course of the war I have been appalled by the want of appreciation of the principles of this subject which, in spite of considerable acquaintance with the formal theory, seemed to prevail in some quarters. I do not refer to mistakes made by competent people—it is human to err—but to the want of appreciation of the true physical meaning of the results expressed by equations. A gyrostat, as ordinarily considered, is a closed system, and its dynamical theory is of a certain kind. But do away with the closedness, and the dynamical theory is quite a different affair. Take, as an example, the case of two interlinked systems which are separately unstable. This compound system can be made stable even in the presence of dissipative forces. A certain product of terms must be positive, so that the roots of a certain determinantal equation of the fourth degree may all be positive. The result shows that there must be angular acceleration, not retardation, of the gyrostat frame. This acceleration is a means of supplying energy from without to the system, the energy necessary to preserve in operation the functions of the system.

I have ventured to think this stabilising action by acceleration of the compound motion very important. It is lost sight of by those who consider and criticise gyrostatic appliances from the usual and erroneous point of view. Also, I believe that it is by analogy a guide to the explanation of more complicated systems in the presence of energy-dissipating influences, and that the breaking down of stability or *death* of the system is due to the fact that energy can no longer be supplied from without in the manner prescribed for the system by its constitution.

I had just concluded this somewhat fragmentary address when the issue of NATURE for July 24 came to hand, containing a report of Sir Ernest Rutherford's lecture at the Royal Institution on June 6. The general result of Sir Ernest's experiments on the collision of α-particles with atoms of small mass is, it seems to me, a discovery of great importance, whatever may be its final interpretation. The conclusion that "the long-range atoms arising from the collision of α-particles with nitrogen are not nitrogen atoms, but probably charged atoms of hydrogen or atoms of mass 2," is of the utmost possible interest. The α-particle (the helium atom, as Rutherford supposes it to be) is extraordinarily stable in its constitution, and probably consists of three helium nuclei each of mass 4, with two attached nuclei of hydrogen, or one attached nucleus of mass 2. The intensely violent convulsion of the nitrogen atom produced by the collision causes the attached nuclei, or nucleus, to part company with the helium nuclei, and the nitrogen is resolved into helium and hydrogen.

It seems that, in order that atoms may be broken down into some primordial constituents, it is only necessary to strike the more complex atom with the proper kind of hammer. Of course, we are already familiar with the fact that radio-active forces produce changes that are never produced by so-called *chemical* action; but we seem now to be beginning to get a clearer notion of the *rationale* of radio-action. It seems to me that it might be interesting to observe whether any, or what kind of, radiation is produced by the great tribulation of the disturbed atoms and continued during its dying away. If there is such radiation, determinations of wave-lengths would be of much importance in many respects.

I may perhaps mention here that long ago, when the cause of X-rays was a subject of speculation and the doctrine that mainly found acceptance was that they were not light-waves at all, I suggested to the late Prof. Viriamu Jones that radiation of extremely small wave-length would be produced if atomic or molecular vibration, as distinguished from what in comparison might be called molar vibration, could be excited. An illustration that suggested itself was this:—Take a vibrator composed of a series of small masses with spring connections. If these masses are of atomic or molecular dimensions any ordinary impulse or impact would leave them unaffected, while vibrations of groups of them, depending on the connections, would result. But the impact on one of the masses of a hammer of sufficiently small dimensions and mass would give vibrations depending on the structure of the mass struck, and independent of the connections, just as the bars of a xylophone ring, while the suspended series of bars, if it swings at all, does so without emitting any audible sound. This is, I believe, in accordance with the theory now held as to X-rays. We now have some information as to the mode of producing a local excitement so intense as to cause, not merely atomic disturbance, but actual disruption of the atomic structure. Further developments of Sir Ernest Rutherford's experiments and of his theory of their explanation will be eagerly awaited.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. P. PHILLIPS BEDSON, D.Sc., PRESIDENT OF THE SECTION.

IN again taking up the work of this section, after an interval of three years, a discontinuity without parallel in the annals of the association, it is natural that our thoughts should turn to the past, and in so doing we are reminded of the gaps in the ranks of those who were accustomed to contribute to the work of our section. In 1916 we met under a shadow caused by the death of Sir W. Ramsay, whose genius added in so many ways to our science. And to-day we have to record the loss of one who in his long life contributed in a variety of ways to the advancement of chemistry, and to whom we owe an addition to the number of elementary substances in the discovery of thallium, one of the early fruits of the use of the spectroscope. The chemistry of the rare earths has been especially illumined by the researches of Sir William Crookes. With physicists we would join in a tribute to the memory of Lord Rayleigh, amongst whose experimental researches is one of special interest to chemists, namely, the revelation of the existence of argon, of which discovery Sir J. J. Thomson has recently written that it was not made "by a happy accident, or by the application of new and more powerful methods than those at the disposal of his predecessors, but by that of the oldest of chemical methods: the use of the balance."

In this connection it is but right that, despite the feelings engendered by the war, I should refer to the passing of two great chemists—Baeyer and Fischer. The former died some two years ago, and the latter within the past two months. Each of them advanced by his experimental researches the progress of organic chemistry, and brought illumination into many of the obscure departments of this branch of science. The field of investigation latterly cultivated by Fischer has revived an interest in the "vital" side of organic chemistry as distinguished from the study of chemistry of the carbon compounds. Moreover, there are many British chemists, amongst them some of the most distinguished, who, as students, received guidance and inspiration from the teaching of Baeyer or of Fischer, and with them we gratefully acknowledge our indebtedness.

Fifty years ago Mendeléeff communicated to the Russian Chemical Society a memoir which has exercised a profound influence on chemical philosophy, and continues to serve as a guide in the interpretation of research and speculations on the nature of the elements. Without entering on the somewhat vexed question as to whom should be assigned the credit of the discovery of the periodic law, I trust I shall not be considered unmindful of the claims of Newlands by adopting the traditional history, and, as is usual, associate this discovery with the name of Mendeléeff, and consequently we may look on this year as the jubilee of the periodic law. Although there is already abundant special literature dealing with this subject, and the periodic system has been assimilated into the teaching of the science, and is dealt with in the text-books of chemistry, in some of which it forms the basis of the system employed in the exposition of the facts and theories of inorganic chemistry, still it appeared to me that I might utilise this as an opportunity of passing in brief review some of the features of the rise and development of the "periodic law."

The memoir, made known to the non-Russian reader by the abstract in German, shows the principle of periodicity, viz. the recurrence of similar properties at regular intervals with increase in the magnitude of atomic weights, the possibility of utilising the atomic weights as a basis of the classification of the elements, the necessity for the revision of the values thus assigned to the atomic weights of certain elements, and finally that the scheme demanded for its completeness the existence of many new elements.

The later writings of Mendeléeff contain the mode of tabulating the elements in the form usually adopted in chemical text-books, portraying the principle of periodicity and showing the grouping of the elements into natural families. But undoubtedly the clearest demonstration of the association between the atomic weights and the physical properties of the elements is that exhibited by the curve of atomic weights and atomic volumes, which is an outcome of the independent studies of these relationships by Lothar Meyer, and, as is well known, shows the members of the natural families of elements occupying corresponding positions on the curve. This curve, with its undulations, corresponding with the series of the elements, has contributed to impress on the mind of the student the relationship between the properties of the elements and their atomic weights, and may have exercised an influence in directing attention to these relationships which the attempts of the earlier workers in this field were not successful in doing.

Mendeléeff's table of the elements was just beginning to figure in the teaching of chemistry in my undergraduate days, and, together with the speculations underlying it, aroused considerable interest and proved an incentive and inspiration for experimental inquiry. Foremost in this country amongst those who by their writings have contributed to spread a knowledge of Mendeléeff's speculations was my fellow-student, Carnelley. His experimental investigations added materially to our knowledge and definition of the physical properties of elements and compounds, which further emphasised the periodicity in the relation of the atomic weights to the properties of the elements, and have provided data from which curves, resembling in contour the atomic volume curve, have been set up.

A valuable guide in fixing the atomic weights of

the elements has been the specific heat which, as the discovery of Dulong and Petit showed a hundred years ago, varies in the case of solid elementary bodies inversely with their atomic weights; or, as it is more usually expressed, the solid elements have the same atomic heat. The investigation of the exceptions to this empirical rule brought out the fact that the specific heat is influenced by temperature, and the study of the influence of low temperatures led Sir James Dewar to the discovery that at about 50° Absolute the atomic heats of the elements are a periodic function of the atomic weights. Further, the graphic representation of this relation gives a curve very similar in its course to that of the atomic volume curve. So that the specific heat is another of the physical properties to fit into the periodic scheme.

The necessity for a revision of the atomic weights of certain elements, as pointed out by Mendeléeff, has induced several workers to direct their energies to the solution of the problems indicated, so that in our present-day tables many of the anomalies of position and sequence which existed in the earlier schemes have disappeared. Tellurium has still resisted all attempts to bring it into order, with an atomic weight less than that of iodine, which its association with sulphur and selenium demands. The interesting attempts to decompound tellurium have so far remained unfruitful.

But undoubtedly the most fascinating feature of the periodic system is that "it allows the discovery of many new elements to be foreseen." This and the manner in which Mendeléeff, in full conviction of the truth of the "periodic law," boldly assigned properties to those elements required to fill the blank spaces in the table of the elements, and the verification within twenty years in three instances of these prophetic specifications have contributed to the recognition and firm establishment of the "periodic law" as an article of belief in chemical philosophy, and to make it the mainspring and inspiration of the greater part of modern inorganic research.

The discovery of argon, the announcement of which formed a notable feature in the proceedings of the association at the Oxford meeting in 1894, and the recognition in it of an element with an atomic weight of 40, raised doubts in the minds of some as to the validity of the scheme of the elements based upon the periodic law. It was indeed a time of testing the faith. The suggestion that argon would prove to be a modified form of nitrogen was brushed aside by the incontrovertible establishment of it as an element, endowed only with specific physical properties and distinguished from all known elements by its lack of any of those activities which characterise the remaining elements. But argon was not destined to enjoy a splendid isolation for long. The researches of Sir W. Ramsay soon brought helium to earth, and he and his colleagues provided a number of companions for argon. So, in a very short period, was recognised the existence of a group of gaseous elements forming a natural family, the molecules of which are monatomic, the members of which are distinguishable by their spectra and atomic weights, but are all in agreement in their unreadiness to take part in any chemical change. This inertness or nonvalence provided a simple means of reconciliation with the periodic scheme of the elements, as all that was required was simply to add to the eight groups of the table of elements a zero group containing helium, neon, argon, krypton, and xenon, and with niton, the emanation from radium, as a recent addition. If we are to accept Mendeléeff's suggestion, the zero group should contain a member lighter than hydrogen in series i., and in a zero series a still lighter representative of the elements of the zero group, which he has postulated as the "æther" of the physicist.

Thus the discovery of argon has formed a starting-point in the development and a justification of the natural system of the elements, but it still remains, to make the tabulation complete, that provision should be made for the accommodation of the rare earths. The paper published by Werner in 1905, under the title "A Contribution to the Development of the Periodic System," shows how this can be satisfactorily accomplished.

The elements of the argon group form a valuable extension to the periodic system, and the knowledge acquired in the investigation of these substances has proved serviceable in the solution of problems in the realms of science and of industry. The knowledge of the properties and behaviour of helium was destined soon to play a part in the solution of the riddle of the radio-active elements, whilst it is specially noteworthy that argon, the "idle one," should have been pressed into industrial service.

This fact suggests the thought that idleness has its uses, and at the present time how satisfactory would it be were we able to find useful application for a quality which appears to be plentifully and widely distributed in this country.

The history of helium is still more astonishing, for not until thirty years after its existence had been surmised from spectroscopic observations of the sun was this element found to have a terrestrial existence, and now, as one of the achievements of science during the war, we may look on its production in bulk as a commercial proposition. Moreover, we are told "that the advances made in the production of helium warrant the opinion that, had the war continued after November 11, 1918, supplies of helium at the rate of 2,000,000 cub. ft. per month would have been produced within the Empire and the United States, and helium-filled aircraft would have been in service" (NATURE, July 17, 1919).

Some of the speculations to which the periodic system of the elements has given rise have been the subjects of communications to this section.

At the Aberdeen meeting Carnelley, whom I have already mentioned as an ardent worker in this field, gave an account of a scheme based on the conception that the elements are composite, having relations similar to those exhibited by the paraffin hydrocarbons and the isologous series of radicals derived from them. He regarded the elements, other than hydrogen, as made up of two simple elements, A and B. A he identified with carbon, with the atomic weight of 12, and B was assumed to have a negative atomic weight of 2.

In the following year, at Birmingham, Sir W. Crookes devoted his address to this section to an exposition of his ideas of the "genesis of the elements," a subject to which he on many subsequent occasions returned, and amplified in the light of recent discovery. The process of evolution of the elements from a primal "protyle" is depicted as taking place in cycle after cycle, in each cycle the "unknown formative cause" scattering along its journey clusters of particles corresponding with the atoms of the "elements," forming in this way a series such as that beginning with hydrogen and ending with chlorine; a repetition of the movement under somewhat altered conditions giving rise to a series of similarly related elements, and thus homology, which is shown by the members of the natural families, is provided for.

The investigations of Sir J. J. Thomson on the discharge of electricity through gases have established the divisibility of the atoms, and in his "Corpuscular

Theory of Matter" he has given us conceptions of how atoms may be constituted to provide a series so related that they reflect, if not reproduce, many of the chemical characters of the elements and their periodic relation to atomic weights.

With the discovery of radium and its remarkable properties we have been brought in contact with an element undreamt of in our philosophy. The interpretation of the results of the investigation of this element has called for drastic changes in our conception of an element. The pursuit of the researches of the radio-active elements, guided by the theory of the spontaneously disintegrating atom propounded by Rutherford and Soddy, has served to reveal facts which lend a special emphasis to many passages in the address of Sir W. Crookes to which I have already referred.

For instance, the passage in which he said: "Should it not sometimes strike us, chemists of the present day, that after all we are in a position unpleasantly akin to that of our forerunners, the alchemists of the Middle Ages? The necromancers of a time long past did not, indeed, draw so sharp a line as do we between bodies simple and compound; yet their life-task was devoted to the formation of new combinations, and to the attempt to transmute bodies which we commonly consider as simple and ultimate—that is, the metals. In the department of synthesis they achieved very considerable successes; in the transmutation of metals their failure is a matter of history."

Or again, when he propounded the question: "Is there, then, in the first place, any direct evidence of the transmutation of any supposed 'element' of our existing list into another, or of its resolution into anything simpler?"—a question to which he, Sir William Crookes, was at that time forced to reply in the negative, whereas to-day many instances might be cited in support of an affirmative answer to this question. Radio-activity has supplied a method of analysis—radio-active analysis—surpassing in delicacy any of the previously known methods for the examination of material substance; the application of these methods has not only added to the list of elements, but also new classes of elements. First, elements indistinguishable and inseparable by chemical means, yet differing slightly but definitely in their atomic weights. The existence of these "isotopes," as Soddy styles them (a name giving prominence to the fact that such elements occupy the same place in the table of the elements), demonstrates that absolute uniformity in the mass of every ultimate atom of the same chemical element is not an essential, but that "our atomic weights merely represent a mean value around which the actual atomic weights of the atoms vary within certain narrow limits" (Crookes, Address to Section B, 1886).

Whether the possibility of separating isotopes, recently suggested by Dr. Lindemann and Dr. Chapman, will be found capable of experimental realisation, must be left to the future to decide; in fact, in this matter we must adopt the attitude, prevalent in other than scientific circles, of "wait and see."

The investigations in the field of radio-activity have further brought to light that identity in atomic weight may be associated with difference in chemical properties, revealing the existence of a further class of elements for which Dr. Stewart suggests the name "isobares." Further, Dr. Stewart considers that isobaric elements are to be found, not alone amongst the radio-active, but some of the normal elements exhibit properties which may be explained on the assumption that they are isobarics. Thus the compounds formed from iron are regarded as indicating the existence of three irons, all having the same atomic weight. One of these, termed ferricum, is tervalent; one, ferrosum, is divalent; whilst the third, ferron, is inert and takes no part in chemical changes. The three are, under certain conditions, mutually interconvertible. This last condition does not apply in the case of the radio-active isobares.

The elements are to be regarded as divisible into three classes:—(1) Isotopic elements, each set of which have different atomic weights but identical chemical properties; (2) isobaric elements which have identical atomic weights but different chemical properties; and (3) normal elements which differ from each other both in atomic weights and chemical properties.

The discovery of X-rays may be acclaimed as having added a new sense to aid us in our investigation of material objects, and among their innumerable services may be reckoned the results which have followed from the investigations of the X-ray spectra of the elements by the late Lieut. Moseley, whose death in Gallipoli in 1915 is one of the many tragedies of the war specially deplored in the scientific world. From the analysis of the X-ray spectra Moseley has shown that for each element a value can be deduced, which is styled the atomic number and represents the space in the atomic table the element should occupy. The researches of Rutherford and Andrade on lead and radium B have proved that "isotopes" have the same atomic number. Whatever may be the ultimate explanation of the meaning of the atomic numbers, their experimental determination has already proved valuable in the solution of some of the anomalies of the periodic table. In addition to the case of isotopes, just referred to, the number of elements between hydrogen and uranium is fixed by finding 92 as the atomic number for uranium, and, further, Moseley's work has revealed that the atomic numbers are in agreement with the order of the chemical sequence, rather than the order of the atomic weights, which is of special interest and value in the cases of tellurium and iodine, and of potassium and argon, the decision in each case proving a welcome support to the position in the table assigned to these elements on chemical considerations.

Again, Moseley's atomic numbers remind us of the arrangement of the elements adopted by Newlands in his communication to the Chemical Society of 1866, in which he set forth the "law of octaves," the precursor of the periodic law.

In concluding this brief sketch, cognisance should be taken of the speculations of physicists as to the structure of the atom. Already several models of the atom are in the field which leave the uncuttable Daltonian atom far out of view; still, in a measure they help to an understanding of some of those regularities exhibited by the elements, and set forth in the natural system. Valency and its vagaries, which we are accustomed to describe by phrases such as "variable valency," "selective valency," and the like, still call for a full explanation.

I purpose now to direct attention to matters of another nature, which appear to me of interest to chemists, and to that extent have a bearing on the welfare of chemistry in this country.

Among the numerous revelations and surprises of the past five years has been the realisation on the part of the public and the Government of the importance of the chemical industries to the national well-being. The apathy and indifference of pre-war times were replaced by an apparently lively interest in things chemical, and there was what in the religious world would be styled a revival.

Politicians, the Press in all its varied forms, daily, weekly, monthly, and quarterly, took up the subject

of our industrial insufficiencies and emphasised in various ways the importance of research in connection with our industries. Again, the coal-tar colour industry furnished, as it had done again and again, some thirty to forty years ago, the text from which research and its importance was preached. This time the reiteration had the effect that the "aniline phantasm," as I have seen it described, was recognised as a "key industry," important to the vitality of the manufacture of textiles; with the result that the Government, discarding its fiscal policy, was induced to subsidise the enterprise for the manufacture of dyes and other coal-tar products. The negotiations preceding the formation of British Dyes, Ltd., have been remarkable as revealing that, in the eyes of some at any rate, special knowledge is a "dangerous thing," and, in fact, was deemed sufficient to exclude its possessors from a seat on the directorate. This is all the more remarkable, as the history of similar enterprises in Germany shows the *personnel* of the directorates to be made up of university trained men and, in not a few instances, of professors. So that in Germany academic distinction and theoretic learning are not considered as excluding the possession of commercial acumen and those other qualities needed in a successful man of business.

In the early stages of the war the demand for explosives was met by the expansion of already existing factories, the increase in staff of which called for many additional men with chemical training, a call which become unprecedented and insistent when the national factories were founded, so that men and women with a chemical training found an opportunity of putting their knowledge at the service of their country. And in not a few instances those who, for financial reasons, had at the close of their college career taken up a less congenial employment were able to return to the practice of chemistry, for which in their student days they had specially fitted themselves.

In the foreword of the publication "Reports on Costs and Efficiencies for H.M. Factories," issued by the Ministry of Munitions, we are told that only "when it was decided to commence the erection of new and national factories, and an attempt was made to collect from existing factories the necessary technical data and assistance, did it become evident that, due to the extraordinary demands of the war, there was —practically throughout the entire country—a regrettable lack of available accurate technical data, and an even greater lack of trained technical men, more particularly chemical engineers,"

To anyone acquainted with the conditions existing in this country in pre-war days, the lack of "trained technical men" is no matter of surprise. In fact, one cannot fail to be astonished at the remarkable development of chemical manufacture which has taken place under the directing influence of Lord Moulton in response to the call from Army and Navy. That men were found capable of taking a part in these varied undertakings cannot, at any rate, be credited to the encouragement which the teaching of chemistry or the students of the science had received from those directing industries which employ or should employ the services of chemists. It is no uncommon experience to find the chemist employed simply in the analytical testing of raw materials and manufactured products, and even in the working of processes under their control the potentiality of the chemist is not utilised to the full, as is evident from the following, which is a quotation from the preface to the brochure issued by the Ministry of Munitions to which I have already referred: "Since the beginning the policy of the Department with regard to our national factories has been to aim at maximum efficiency in respect of cost and usage of materials.

"For this purpose the greatest efforts have been made to place before all those who are in any way responsible for control full details concerning the working and costs of the factories. This was rather an innovation in the field of chemical manufacture, as until comparatively recently, either intentionally or through negligence, it was customary at many chemical plants to keep the chemists in complete ignorance, not only of the cost at their plants, but also even of the efficiencies.

"It is amazing that manufacturers can expect improvements in chemical processes when their chemists are kept in ignorance of such vital facts.

"It has happened very often that as soon as detailed figures were seen by chemists at a plant, important alterations and improvements have at once been suggested, the need for which would otherwise never have been noticed."

The condition of service indicated in the passage quoted, together with the low scale of remuneration which obtained hitherto in chemical industries, help to explain the scarcity of the kind of scientific labour referred to in the quotation I have made from the "Foreword."

But are we not told and invited to believe that all this is changed, that the records of the magnificent achievements of British chemists in the war have so educated the people, and may we say, the Government also, that the practitioners in chemistry will no longer find it essential that in describing their vocation they should be required to add, unless for special reasons, such prefixes as "analytical," "research," "scientific," or "engineering" to the word chemist, secure in the feeling that by describing themselves as "chemists' their standing, training, and profession will be correctly understood?

Still, a feeling akin to despondency, if nothing worse, is pardonable when, realising the fundamental importance of chemistry to our industries, and the thousand and one ways chemical research has ministered to the amenities of our everyday life, there should exist, not alone in the mind of the general public, but of the educated also, such a lack of information as has been revealed during the past few years—to wit, the myth woven into the history of the production of glycerine, the confusion in the minds of legislators between phosphates and phosgene. More serious, however, is the fact that the method of investigation employed by the chemist is so little appreciated or understood as to lead one to imagine that the discoveries and achievements are the results of a species of legerdemain. The production of new colours, a succession of happy thoughts, and that "by an accident the secret of synthetic indigo was unlocked." This last is a quotation from a review entitled "The Value of Scientific Research," published some three years ago, and is typical of much that passes muster in appraising the value of chemical research. That the unravelling of the constitution of indigo which occupied Baeyer and his pupils some thirteen years—the account of these investigations covers some 180 pages of Baeyer's collected works—should be summarised in this way appeared to me to call for a protest. My protest was made, and I attempted to put the matter in the correct light, showing the synthesis of indigo to be, indeed, a brilliant example of the value of theory and of a practical illustration of the importance of the chemist's conception of the architecture of molecules, as exemplified by Kekulé's theory of the constitution of benzene. The protestation evoked a reply from a correspondent signing himself D.Sc., Ph.D., who sought

to justify the description of the revelation of the secret of synthetic indigo by reference to an accident which occurred in the investigation of the processes for the manufacture of phthalic acid and certainly greatly facilitated the production of this substance—an intermediate in the manufacture of artificial indigo. So, if the initiated emphasise the unessential, why should we blame the layman and be surprised that well-ordered and planned design should appear to be but the workings of chance, for every such achievement is a witness to the conquest of well-founded theoretical speculation?

But I do not wish to conclude on a despondent note, nor is it right that I should do so in view of the many activities operating for the promotion of scientific research, and of such evidence as that supplied by the magnificent endowment of the chemical department of the University of Cambridge, all of which are evidences of what we may reasonably hope to be a happy augury for the future of chemistry and chemists in this country.

NOTES.

THE James Watt centenary celebrations in Birmingham were opened with lectures by Prof. F. W. Burstall and Prof. Hele-Shaw on Tuesday morning (September 16). In the afternoon there was a memorial service at Handsworth Parish Church, in which Watt, Boulton, and Murdoch were buried, an address being delivered by Canon E. W. Barnes, Master of the Temple. This was followed by a garden-party at Heathfield Hall, and a reception by the Lord Mayor at the Council House. On Wednesday morning, as we go to press, lectures are to be given by Sir Oliver Lodge, Prof. Alex. Barr, and Prof. J. D. Cormack, and in the afternoon visits will be made to some of Watt's engines. In the evening will be held the centenary dinner. On Thursday the University will hold a special Degree Congregation to confer honorary degrees on the American Ambassador (the Hon. J. W. Davies), Sir Charles Parsons, Vice-Admiral Goodwin, M. Rateau (of Paris), Sir George Beilby, Col. Blackett, Prof. Barr, and Mr. F. W. Lanchester. The response to the appeal for the memorial fund has up to the present been very meagre, and unless large additions are made to the subscription list the realisation of even one of the objects of the fund will not be possible. It is to be hoped that a marked improvement may be made during the week.

SUMMER time is to end this year at 2 a.m. on September 29. Each year the terminal dates of summer time have varied, and, though the dates will, of course, be known to our future compilers of natural phenomena, the use of summer time can scarcely fail to result in some errors. Even so simple a change as that of the Gregorian calendar has been attended by mistakes. Some years ago, for instance, the late Sir Edward Fry referred to some entries on British earthquakes in the diary of John Wesley (NATURE, vol. lxxix., 1898, p. 08). He remarked that the London earthquakes of February 8 and March 8, 1750, which Wesley describes, are not mentioned in Mallet's Catalogue. Wesley's dates are correctly given, for the Gregorian calendar came into force after September 2, 1752. Mallet, however, gives the days in new style as February 19 and March 19. The error in this case is easy to detect; but, unless the letters "G.M.T." or the words "summer time" are added, it may be difficult to decide whether records of an earthquake at, say, 2.12 and 3.8 relate to the same shock at about 2.10 G.M.T. or to different shocks.

WE regret to learn from Dr. G. C. Simpson, Director-General of Observatories, Simla, that Mr. W. L. Dallas, who was Scientific Assistant to the Meteorological Reporter to the Government of India from 1882 to 1906, passed away at Simla on August 5. Mr. Dallas's original meteorological work was devoted almost entirely to a study of the weather conditions over the Indian seas, although he published a few papers on more general subjects. He discussed for the Government of India the marine observations of the Indian seas collected by the London Meteorological Office during twenty years—1856–75. He also investigated the nature and causes of storms in the Arabian Sea, using all records available for the period 1648–1889, on which inquiry all later work undertaken by the India Meteorological Department for warning ships approaching India from the west was based. Mr. Dallas fittingly closed his long official connection with the India Meteorological Department by the compilation of a meteorological atlas of the Indian seas, which will be found in use on most ships visiting the East.

MR. EDWIN O. SACHS, whose death we announced last week, will be remembered mainly by his keen interest and untiring activity in relation to all questions regarding fire protection and fire prevention. The terrible holocaust of the Paris Charity Bazaar fire in 1887 led Mr. Sachs to form the British Fire Prevention Committee, of which he was the chairman and guiding spirit up to the time of his death. In his work with the committee Mr. Sachs was supported by a number of public men and professional friends. Thanks to his energy and devotion and his able leadership, the committee's work, from very small beginnings, soon covered a vast field of activity, which widened from time to time until the foundations of a comprehensive organisation were firmly laid. The large number of tests undertaken by the committee were made in a specially constructed testing station which Mr. Sachs designed, and to which he not only gave unstinted and devoted labour, but also largely financed. This testing station, which has been enlarged and improved from time to time, was the first of its kind, and has served as a model for similar centres of investigation throughout the world. The numerous activities of the committee—which during the war were greatly increased, and included arrangements for a voluntary fire survey force for more than two thousand war hospitals, camps, and factories, also research work of the highest importance to the nation—were initiated and guided by Mr. Sachs's unceasing energies, even during his latter years. All this work on the committee, as well as his other public activities, were rendered entirely voluntarily, and in all he did he was inspired by the highest ideals.

DURING the evening of September 11 an earthquake shock, causing considerable damage, was felt in the region of Monte Amiata, near Siena. At San Casciano several houses were wrecked. A slighter earthquake was also felt on September 12 at Ebingen (Würtemberg).

THE *Times* correspondent at New York reports that on September 13 Mr. Roland Rohlfs, a testing pilot with the Curtiss Aeroplane Corporation, rose from Roosevelt Field, Long Island, to a height of 34,200 ft. This "record" is not officially confirmed, but Mr. Rohlfs will try on the first favourable day to make an authenticated attempt to exceed the altitude believed to have been reached by him.

ON May 20 the volcano Kloet, in Java, discharged suddenly a great quantity of hot mud, which, spread-

ing out in three streams, destroyed the town of Blitar and about thirty villages, and caused the death of several thousand persons. The place was visited by an exploring party two days later, and an interesting two-page reproduction of one of the photographs of the mud-stream is given in the *Illustrated London News* for September 13 (pp. 396–97).

AT a joint meeting of the Royal Asiatic Society, Société Asiatique, American Oriental Society, and Scuola Orientale of the University of Rome, recently held in London, Prof. A. T. Clay, of Yale University, described the efforts of American scholars to free themselves from dependence on Germany for research work in Asia. Several young Assyriologists in America are now devoting themselves to research work. Yale University has taken over the work of Sir W. Ramsay at Antioch, and the American School of Oriental Research in Palestine, which was closed on account of the war, is now to be re-opened on a more extensive scale. At least one professor and several students will be sent annually from Yale to direct operations, which will be carried out in co-operation with the British School, which will be founded on a more important basis.

STUDENTS of the mygalomorph spiders will do well to consult a critical systematic paper on South African species by John Hewitt in the *Annals of the Transvaal Museum* (vol. vi., pt. 3).

SOME results of a collecting expedition to Korinchi Peak, Sumatra, are published in the Journal of the Federated Malay States Museums (vol. vii., pt. 3, 1919). Descriptions, with excellent figures, of a number of Diptera, by F. W. Edwards, of the British Museum, are especially noteworthy.

WE have received the seventeenth Report of the State Entomologist of Minnesota. In addition to articles of economic interest, it contains several papers of systematic value, such as O. W. Oestlund's contribution to the classification of aphids and F. L. Washburn's summary of the Hymenoptera of the State. The illustrations in this Report are exceptionally praiseworthy.

DRS. S. HADWEN and A. E. Cameron, working for the Canadian Department of Agriculture, have made a definite contribution to our knowledge of horse bot-flies (Bull. Entom. Research, vol. ix., pt. 2) by their observations on the eggs and early larvæ of *Gastrophilus haemorrhoidalis* and *G. nasalis* as compared with *G. intestinalis* (*equinus*). The first-named species has stalked eggs which are laid on the hairs of horse's lips, while the second lays on the hairs of the intermaxillary space. It is possible that the newly-hatched larvæ may penetrate the horse's skin in these regions, as they were found to bore into the mucous lining of the mouth and also into the tongue of a recently killed calf.

THE possibilities of the manufacture of paper-pulp in Australia is the subject of a Bulletin (No. 11) issued by the Advisory Council of Science and Industry of the Commonwealth of Australia. The bulletin describes the results of some preliminary investigations of the native sources of wood-pulp and pulp from fibre-plants. The most satisfactory results have been obtained with karri and other species of eucalypts, and it is suggested that a thorough survey of the resources might indicate the possibility of building up a wood-pulp industry in Australia. As regards the fibre-plants, a number were found on testing to be unsuitable for paper-making. It is unlikely that either of the grasses Lalang or Marram, which have been used for pulping purposes, could be employed profitably in Australia, and negative results have also been obtained with prickly pear. A blend of 20 per cent. of a sedge (*Gahnia decomposita*) and 80 per cent. karri-pulp is reported as very satisfactory. The conclusion is that if Australia's demands for paper are to be supplied from native sources, the principal material to be used for some years to come must be straw, of which large quantities are produced within a hundred miles' radius of Adelaide.

VARIOUS memoranda and letters on "The Reconstruction of Elementary Botanical Teaching," which appeared in the *New Phytologist* during 1917–18–19, have been brought together in pamphlet form. As indicated by the letters, the teaching refers almost exclusively to the elementary university course, and the participants in the discussion are, with few exceptions, engaged in teaching of a university standard. The discussion originated from a memorandum by five botanists who pleaded for a more important place for plant physiology as compared with morphology in the elementary course. This was regarded by some eminent morphologists as a challenge, to which they replied with some vigour. The discussion brings out the fact that botany is a wide subject, attracting students of widely differing temperaments, and there is real difficulty in planning an elementary course which shall form an adequate introduction to the different branches in one or more of which the student may subsequently specialise. As regards the *motif* of the elementary course, it is important that the plant should be studied as a living organism and as part of a larger organisation which is closely associated with its environment. But present-day plant-life is not merely the expression of present-day environment, but largely the outcome of past history; and the neglect of the study of history may be disastrous. There is a considerable amount of elementary botanical teaching outside the universities, and the point of view and methods suitable for the university student are not necessarily those suited to boys and girls at school.

ALTHOUGH the statement is made quite definitely in many text-books that formic acid occurs in the stinging hairs of the common nettle (*Urtica dioica*), the proof has not hitherto been very satisfactory. In early experiments the nettles were cut up, distilled with water, and reactions of formic acid obtained on testing the distillate. Later observers, however, have found that various parts of plants yield formic acid when tested in a similar manner. Hence it was not certain that the acid in the earlier experiments had come from the stinging hairs; it might have been derived from the general plant tissues. Moreover, one of the chief chemical reactions of formic acid, namely, its power of reducing salts of silver and mercury, is not necessarily a conclusive proof of the presence of the acid under the particular conditions of these earlier experiments, since other "reducing" substances might also have been present. The question, however, appears to have now been definitely settled through some ingenious experiments devised by Dr. Leonard Dobbin (Proceedings of the Royal Society of Edinburgh, vol. xxxix., ii., No. 11). By pressing the leaves of growing nettles between dry filter-paper impregnated with barium carbonate, the contents of many thousands of hairs were absorbed without contamination by juices from any other part of the plant. After appropriate treatment the product yielded barium and lead salts, which were crystallised on glass slides, and the two formates identified under the microscope. Whether or not formic acid is the main cause of the intense irritation produced by nettle-

stings is a further question; the active irritant has been regarded by one investigator as being probably not formic acid, but an enzyme.

THE cause of the colours of "Blue John" and other varieties of fluorite has long been a matter of doubt and controversy. During the last two years Messrs. B. Blount and J. H. Sequeira have carried out an interesting investigation of the problem, and their results are now briefly described in the Transactions of the Chemical Society (vol. cxv., p. 705, 1919). They have carefully analysed blue and white varieties of the mineral, tested the powdered material by extraction with organic solvents, examined the gases occluded by "Blue John," and subjected several types of fluorite to "raying" by exposure to radium and X-rays. They conclude from their experiments that there is no substantial difference between white fluorite and the blue, green, and amethystine varieties, except in the presence of a small amount of organic matter to which the colours are ascribed. The state of dispersion of the organic matter is not discussed. It is already ascertained that the blue colour of certain varieties of rock-salt is due to a colloidal dispersion of sodium in sodium chloride, and the blue colours of sodalite and ultramarine are almost certainly due to a similar cause. To correlate the colours of fluorite with the presence of different amounts of organic matter therefore still leaves the core of the problem unsettled; and it is to be hoped that the authors will continue their work by applying methods of X-ray analysis and ultra-microscopy in the hope of demonstrating the degree of dispersion of the organic matter, molecular or colloidal, in each of the varieties of fluorite on which their present work has been conducted.

THE Union of Technical Men (*Bund technischer Berufsstände*), which has recently changed its name to the Imperial League for German Technology (*Reichsbund deutscher Technik*) is now publishing a regular weekly periodical, which reflects the opinions of the leaders of technical thought in the country. Questions affecting, in particular, the work of reconstruction find an important place in the journal. It is interesting to note that already more than one great conference or Technical Parliament has been held, and energetic measures are being taken with a view to ensure the adequate representation of scientific and technical thought on all public bodies. An announcement in the publications of the League states that a daily paper (*Die Arbeit*) will make its appearance as soon as the difficulties connected with the release of paper supplies are overcome.

WE have received recently a copy of *The Chemical Technology*, a monthly journal devoted to chemistry and chemical technology, published in Tokyo. It is printed chiefly in the Japanese language, but contains a section of about eight pages in English. This consists mainly of commercial notes upon chemical products, such as dyestuffs, alkaloids, wax, menthol, and peppermint oil. The Japanese columns contain a number of articles upon branches of technological chemistry, and some of a more general nature, including one on "Science and its Future," by Mr. S. Oguri. Judging by their titles, the articles cover a wide range of subjects, and indicate that chemists in Japan are quite awake to the importance of their science to the nation's industries. It may be noted, in passing, that the journal contains several American advertisements, but not a solitary British one.

FROM the director of the Wellcome chemical research laboratories we have received copies of sixteen scientific papers published during the last few years by the institution in question. They are chiefly accounts of investigations upon materials likely to be of value in medicine. On one hand, plants used as official or domestic remedies have been examined more thoroughly than hitherto; and, on the other, active constituents of drugs, such as alkaloids, have been investigated with the view of determining their constitution and facilitating the possible synthesis of similar therapeutic agents. The distribution of these memoirs to scientific institutions, formerly made periodically, was suspended during the period of the war, and is now being resumed. The results of the investigations, however, have already appeared in the Transactions of the Chemical Society and the *Pharmaceutical Journal*, so that they need not be mentioned here in detail. It will suffice to say that they form an important contribution to our knowledge of the medicinal plants examined, and are a testimony to the excellence of the work done at the laboratories.

THE importance of having a thoroughly trustworthy instrument for detecting and measuring the amount of any combustible gas present in the air at any time has led the Bureau of Standards at Washington to investigate the working of existing instruments and to design a further instrument depending on a new principle, which appears to have a great future before it. It depends on the combustion which takes place about a platinum wire in the mixture when an electric current is sent through the wire so as to heat it sufficiently. Three methods of measurement are adopted. The wire may form one arm of a resistance bridge and indicate the amount of gas by the rise of temperature, and therefore of resistance of the wire. Or the current in the wire may be increased until the wire just glows, the increase required being less as the amount of combustible gas increases. Or the heat generated by the combustion may be used to heat a bimetallic strip, the bending of which increases as the heat generated, and therefore as the amount of gas present. Full details of the instruments, with drawings, are contained in Scientific Paper No. 334, by Messrs. E. R. Weaver and E. E. Weibel, of the Bureau.

VOL. iii. of the Memoirs of the College of Science, Kyoto Imperial University, contains an account of a series of researches on the electrical resolution of spectral lines (Stark effect). The method employed was that originated by Lo Surdo, in which the intense electric field in the cathode dark space of a vacuum tube is utilised. The elements studied include H, He, Li, Ca, Mg, A, N, and O, and a number of new and interesting results have been obtained. The observations on the helium spectrum are particularly complete, and are summarised diagrammatically in a manner which brings out clearly most of the characteristic features of the effect. Special attention is given to the phenomenon of "isolated components," which only exist in sufficiently strong fields, and seem to be exclusively associated with a diffuse type of series. This latter property, together with other features of their observed behaviour, would suggest that it may be legitimate to regard them as a special class of satellite. Another observation of much interest refers to certain combination series lines which make their appearance only in intense electric fields. The examination of the secondary spectrum of hydrogen yielded fifty-four affected lines; these results, in conjunction with the Zeeman effects already on record, should be of material assistance in elucidating the structure of this spectrum. Among other conclusions of general interest may be mentioned the confirmation of the view, which previously rested on somewhat fragmentary evidence, that arc lines are affected by

electric fields to a much greater extent than enhanced lines of the same element.

ALTHOUGH there is a general belief that underfed individuals are more susceptible to infection than well-fed persons, and that when the former contract a disease they show less resistance and are more prone to succumb to it, there is no definite scientific evidence even of a general character to support the theory. The study of the interesting question whether the immunity of an animal to disease is affected by a rigorous and prolonged dietetic deficiency is a natural outcome of the work on accessory food factors which has recently been carried out at the Lister Institute, and the current issue of the *Biochemical Journal* contains a suggestive paper on the subject by Dr. S. S. Zilva. Immunity is a complicated biological phenomenon which does not lend itself to quantitative estimation, but certain phenomena which accompany it, such as phagocytosis, complement fixation, and agglutination, can be estimated quantitatively for comparative purposes. Dr. Zilva has studied the effect on amboceptor and agglutinin formation and the complement content of the blood of rats, of diets deficient in (*a*) the elements calcium, iron, potassium, chlorine, phosphorus, and sodium; (*b*) certain amino-acids; and (*c*) the antiscorbutic, antineuritic, and fat soluble A accessory factors, the rat being the animal employed. The diets investigated were (1) those low in the elements mentioned; (2) those containing 12 per cent. and 8 per cent. of caseinogen as a source of protein; (3) those containing 18 per cent. of gliadin as the sole source of protein; and (4) those deficient in each of the three accessory food factors. As a result of several of the deficiencies the animals exhibited restricted growth and poor condition, but, except when the diet was deficient in phosphorus, no differentiation in the titres of the agglutinins and amboceptor could be recorded. Guinea-pigs, whether fed on an unrestricted mixed diet, quantitatively restricted mixed diet, or a scorbutic diet, showed no difference in the amboceptor and agglutinin titres or in the complement activity of their blood.

THE useful select list of scientific and technical books published in the Descriptive Catalogue of the British Scientific Products Exhibition, 1919, has, with the permission of the British Science Guild, been issued separately in pamphlet form by Messrs. A. and F. Denny, 147 Strand, London, W.C.2. The list gives in sixty pages the bibliographic particulars of standard books in the English language in sixteen branches of applied science, from aeronautics to wireless telegraphy. The date and price of the existing edition are shown in each case, and every volume in the list is on sale, so that any of the books ordered can be obtained without difficulty. Messrs. Denny will be glad to send a copy of the list to anyone who will apply to them for it.

THE following volumes are in active preparation for publication by the Hakluyt Society:—"The Chronicles of Muntaner," translated and edited by Lady Goodenough; "Jons Olafssonar Indiafara," translated by Miss B. Phillpotts, edited by Sir R. C. Temple, Bart., 2 vols.; "William Lockerby's Journal in Fiji, 1808," edited by Sir E. F. im Thurn and L. C. Wharton; "A Description of the Coasts of East Africa and Malabar in the Beginning of the Sixteenth Century," by D. Barbosa, translated by L. Dames, vol. ii.; and "Anales del Peru," by L. F. Montesinos, translated and edited by P. A. Means.

A LENGTHY and interesting catalogue (No. 181) has just been circulated by Messrs. W. Heffer and Sons, Ltd., Cambridge. The books (more than 1600 in number) are of a miscellaneous character, but there are sections devoted to archæology, folk-lore, anthropology, and kindred subjects; Irish literature, folk-lore, and archæology; and science and mathematics. In addition, Messrs. Heffer direct attention to collections of flint and bronze implements and of pottery which they have for disposal.

Messrs. George Bell and Sons, Ltd., have completed arrangements with Prof. Moureu for the publication of a translation of "Notions fondamentales de chimie organique." The translation is being made of the fifth French edition, in which additional space is devoted to a more extensive treatment of stereochemistry, and of the relations between chemical constitution and physical properties. There will also be an additional chapter on dyestuffs.

OUR ASTRONOMICAL COLUMN.

COMETS.—Miss Vinter Hansen and Mr. Fischer Petersen have deduced elliptical elements for the comet 1919*b* (Brorsen-Metcalf), and give the following ephemeris:—

For Greenwich Midnight.

	R.A.	N. Decl.	Log r	Log Δ
	h. m. s.	° ′		
Sept. 19 ...	12 7 43	42 46	9·8967	9·5175
21 ...	12 1 24	38 54		
23 ...	11 56 36	35 30	9·8577	9·5935
25 ...	11 52 52	32 28		
27 ...	11 50 0	29 43	9·8168	9·6647
29 ...	11 47 50	27 11		

Prof. Wolf noted that at the end of August the comet was easily visible to the naked eye as a large, round nebula, with central condensation, and a tail. The theoretical brightness is now diminishing, but there is likely to be an increase in physical brightness as perihelion is approached (about October 17). The comet is in conjunction with the sun on September 22; after that date it may be observed to most advantage in the morning sky.

M. Ebell gives the following continuation of the ephemeris of Kopff's periodic comet 1919*a*:—

For Greenwich Midnight.

	R.A.	S. Decl.		R.A.	S. Decl.
	h. m. s.	° ′		h. m. s.	° ′
Sept. 18	19 52 18	7 50	Sept. 26	20 2 12	7 45
20	19 54 40	7 49	28	20 4 51	7 43
22	19 57 6	7 48	30	20 7 34	7 41
24	19 59 37	7 46	Oct. 2	20 10 21	7 38

On September 24, $\log r = 0{\cdot}2755$, $\log \Delta = 0{\cdot}0740$, magnitude 11·7.

Continuation of the ephemeris of comet 1919*c*:—

For Greenwich Midnight.

	R.A.	N. Decl.		R.A.	N. Decl.
	h. m. s.	° ′		h. m. s.	° ′
Sept. 18	14 49 5	16 0	Sept. 30	15 12 47	10 44
22	14 56 46	14 16	Oct. 4	15 21 8	8 57
26	15 4 40	12 30	8	15 29 42	7 10

The comet is brightening slowly, its magnitude on October 8 being 8·5.

THE BLINK MICROSCOPE.—Mr. R. T. A. Innes has an article on this subject in *Scientia* for September. He is one of the chief workers with this instrument, so he speaks with authority. It is unrivalled as the readiest means of picking out all the large proper motions on a pair of plates. Taking the smallest proper motion that can be detected in the case of plates taken twenty-five years apart as $1\frac{1}{4}''$ in this interval, or $5''$ per century, Mr. Innes states that there are about three such stars in each square

degree, or 120,000 in the whole sky. He estimates that the number of stars with sensible proper motion would increase as the square of the time-interval, so that with a century interval there would be 2,000,000 proper motions.

It is explained in the article that the proper motions found by photography are not absolute, since they take no account of the systematic drift of the region of the sky, due to the solar motion. At present photography does not appear to be capable of giving absolute proper motions without the aid of the transit circle. It is necessary to determine absolute places and proper motions of a sufficient number of reference stars on each plate to enable them to be deduced for the remaining stars.

IRRIGATION IN EGYPT AND THE SUDAN.

THE admirable record of agricultural progress achieved under British control in Egypt offers every incentive to further exertions, with a view to increase the productivity of a country so rich in latent possibilities. It is interesting, therefore, to note the resumption of irrigation undertakings, which have been temporarily suspended during the war. During the last generation the Nile has undergone drastic engineering treatment, and now, no longer free to give vent to irregular and wasteful discharges, its valuable waters, conserved and controlled by artificial works, are increasingly administered on systematic lines and directed to those localities where their beneficial influence can be most effectively exercised.

The pioneer dam of Mougel Bey, just below Cairo, restored and raised to a higher degree of utility by the late Sir Colin Scott-Moncrieff, the barrages at Asyût, Esna, and Zifta, and the bolder and more imposing structure at Aswân, are now being followed by other works which will, no doubt, produce results as noteworthy and important.

The schemes at present in hand include three separate projects relating to different sections of the river. There is a scheme for the development of the Gezirah plain of the Sudan on the Blue Nile, just south of Khartoum; another for the benefit of Egypt proper by utilising the flood-waters of the White Nile; and a third scheme of drainage improvement for the deltaic region included in the provinces of Gharbieh and Beheira, lying below Cairo.

The Blue Nile scheme consists of a dam at Makwar, about five miles south of Sennar and 175 miles south of Khartoum, with a canal, some forty miles in length, leading from just above the dam to the district to be irrigated, which is a remarkably level and treeless plain some 300,000 feddâns in extent (a feddân is 1·04 acre). The cotton, which it is capable of producing, will be raised as a winter crop, absorbing the river winter supply without interfering with the summer discharge. The dam will be a work of some magnitude, withstanding, when completed, a head of 40 ft. of water, and capable of coping with a discharge of some 1,250,000 gallons per second in a river subject to sudden and extreme fluctuations.

The White Nile scheme is, fundamentally, a development of the Aswân undertaking, which has now reached the limit of its effective utility. In 1916 the demands of the area under cultivation exceeded the available supply. It is, accordingly, proposed to construct an auxiliary reservoir dam at Gebel-el-Auli, or Gebel Aoli, on the White Nile, capable of impounding an adequate summer supply of water for Egypt, and at the same time reducing the excessive flood-waters of the main Nile. This scheme has been the subject of certain criticisms by Sir William Willcocks, whose own proposal was briefly referred to in the Notes column of NATURE for May 22 last. A subsidiary work is the formation of a channel from the Blue Nile above Sennar, so that the superfluous water from that reservoir may be conveyed to the Gebel-el-Auli reservoir. The Gebel-el-Auli dam will have a pressure-head of 23 ft.

The increased water supply to Lower Egypt, due to the Aswân reservoir, has severely taxed the drainage channels of the provinces of Gharbieh and Beheira, forming the alluvial plain between Cairo and the sea. It is necessary to find some measure of relief, and a solution of the problem is sought in the construction of large pumping installations on the borders of Lake Mareotis and Lake Borollos.

Interesting details of the engineering features of the various projects are given in a series of articles recently published in the *Engineer*, from which most of the foregoing particulars are taken.

BRYSSON CUNNINGHAM.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

STOCK of the value of 300,000*l.* has been presented to the University of California by Mr. E. F. Searles, of San Francisco.

IT is announced that Yale University will receive from the estate of the late Mr. J. W. Sterling approximately 3,600,000*l.*, or about 600,000*l.* more than had been anticipated.

ANNOUNCEMENT is made in the *Times* that Mr. Balfour is to be nominated for election as Chancellor of Cambridge University, in succession to his brother-in-law, the late Lord Rayleigh.

DR. T. STUART, formerly professor of mathematics in Hongkong University, has been appointed lecturer in mathematics, and Mr. G. Mavor, formerly of the Gillingham Technical Institute, lecturer in mechanical engineering at the Loughborough Technical College.

THE sum of 1000*l.* has been given to the applied science department of Sheffield University by Mr. J. D. Brunton, of Musselburgh, for the annual award of a medal and premium for the best metallurgical research work done at the University during the year.

DR. J. F. GEMMILL, lecturer in embryology, University of Glasgow, and in zoology at Glasgow Provincial Training College, has been appointed to the chair of natural history at University College, Dundee, in succession to Prof. D'Arcy W. Thompson.

THE Edith Barnard memorial fellowship in chemistry in the University of Chicago has been endowed through the gift of 600*l.* by the mother, brother, colleagues, and friends of Edith E. Barnard, a former instructor in chemistry in the University. The fellowship has been temporarily maintained since 1916, but it has now been placed upon a permanent basis.

THE Commission for the Relief of Belgium is placing at the disposal of the country the sum of 6,000,000*l.*, which is to be devoted to university education, and will facilitate access to the universities for children of the poorer classes. The Universities of Brussels, Louvain, Ghent, and Liège are each to receive 13 per cent. of the money, the School of Mines at Mons 3 per cent., and the Colonial School 6 per cent.

A COURSE of training in industrial chemistry will begin at the Northern Polytechnic Institute, Holloway, N.7, on September 22. The course is open to the general public, and is adapted to the requirements of demobilised men who desire to qualify for positions

as analytical and works chemists. In addition to the usual training in chemistry and allied subjects, glass-working, instrument-making, and plumbing are also to receive attention. Detailed information may be obtained from the Principal.

UNDER the Government scheme of financial assistance for the higher education of ex-Service officers and men, the total number of grants awarded by the Board of Education now amounts to 9500, including 4000 officers and 5500 men. The courses in respect of which grants have been awarded include more than 2500 for engineering and technological subjects, between 800 and 900 for classics, philosophy, and literature, and about 1200 for pure science and mathematics. Applications are still being received in large numbers, and are being dealt with at the rate of more than 100 a day.

THE new session of the Sir John Cass Technical Institute will commence on Thursday, September 25. The courses of instruction provided are specially directed to the technical training of those engaged in chemical, metallurgical, and electrical industries and in trades associated therewith. Full facilities are provided for those wishing to carry out work associated with the industries in which they are engaged or to undertake special investigations and research. Special courses of higher technological instruction form a distinctive feature of the work of the institute. The curriculum in connection with the fermentation industries includes courses of instruction on brewing and malting, bottling and cellar management, and on the microbiology of the fermentation industries. A connected series of lectures in fuel and power, comprising liquid, solid, and gaseous fuels and their application, electrical supply and control, the transmission of power in works, fuel analysis and technical gas analysis is also included in the syllabus of the chemistry department for the forthcoming session. Full details of the courses are given in the syllabus of the institute, which can be had on application at the office or by letter to the Principal.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 1.—M. Léon Guignard in the chair.—A. **Lacroix**: The mineralogical and chemical constitution of the volcanic lavas of Tibesti. Fourteen complete rock analyses are given, together with a general account of the minerals present.—G. **Humbert**: The measurement of the *ensemble* of the positive classes of Hermite, of given discriminant, in an imaginary quadratic body.—E. **Cosserat**: Some stars possessing a total annual proper motion of more than 0·5″. The movements of stars mentioned by A. van Maanen in 1915 and 1917, and one pointed out by Wolf in 1916, have been studied by means of the photographic catalogue of the Toulouse Observatory. The positions of seven stars are provisionally given possessing a proper motion of more than 0·5″.—M. **Tilho**: The raw materials and railways of tropical Africa north of the equator. A discussion of the best railway scheme, taken in conjunction with existing railways, for opening up northern Africa.—E. **Kogbetliantz**: New observations on ultra-spherical series.—G. **Guillaumin**: Contact forces in heterogeneous solids, with special reference to reinforced concrete.—B. **Jekhowsky**: Orbit of Metcalf's comet 1919*b*. The calculations are based on observations made on August 21, 22, and 23.—C. L. **Charlier**: The spiral nebulæ. As a working hypothesis it is supposed that spiral nebulæ are formed by the collision of an extra-galactic body with the solar system. This hypothesis explains simply two well-established facts.—A. **Soret** and R. **Couespel**: A multiple-valve microphone.—A. **Boutaric**: The calculation between the ratio of the vapour-pressure of a solid and that of the surfused liquid at varying temperatures.—J. **Guyot** and L. J. **Simon**: The action of dimethylsulphate and the alkaline dimethylsulphates on dry alkaline bromides and chlorides.—J. **Delpech**: The pure "B" powders. These specimens were prepared by complete solution of the nitrocellulose, followed by a filtration through cotton-wool under pressure. The powder thus produced is transparent, and doubtful portions can be detected by inspection.—MM. **Vermorel** and **Dantony**: The comparative usefulness of ordinary Bordeaux mixtures and mixtures prepared with the addition of casein for the preservation of grapes. The addition of casein is very advantageous.—MM. G. **Bertrand**, **Brocq-Rousseau**, and **Dassonville**: The destruction of bed-lice by chloropicrin. Quite moderate amounts of chloropicrin suffice for the practical disinfection of beds.

BOOKS RECEIVED.

The Exact Diagnosis of Latent Cancer: An Enquiry into the True Significance of the Morphological Changes in the Blood. By Dr. O. C. Gruner. Pp. vii+79. (London: H. K. Lewis and Co., Ltd., 1919.) 7*s*. 6*d*. net.

The Planting, Cultivation, and Expression of Coconuts, Kernels, Cacao, and Edible Vegetable Oils and Seeds of Commerce. A Practical Handbook for Planters, Financiers, Scientists, and others. By H. Osman Newland. (Griffin's Technological Handbooks.) Pp. vi+111+xi plates. (London: Charles Griffin and Co., Ltd., 1919.) 6*s*. net.

CONTENTS.

PAGE

Science and Sociality. By Sir Arch. Geikie, O.M., K.C.B., F.R.S. . . . 45
Botany of Cultivated Plants. By F. K. . . . 46
Our Bookshelf . . . 47
Letters to the Editor:—
Sea-fishery Investigations and the Balance of Life.—Prof. Walter Garstang; Prof. W. C. McIntosh, F.R.S. . . . 48
Dr. A. G. Vernon Harcourt, F.R.S. By H. B. D. . 49
Dr. Charles A. Mercier . . . 50
The British Association at Bournemouth . . . 51
Section A—Mathematical and Physical Science—Opening Address by Prof. A. Gray, M.A., LL.D., F.R.S., President of the Section . . . 52
Section B—Chemistry—Opening Address by Prof. P. Phillips Bedson, D.Sc., President of the Section 59
Notes . . . 63
Our Astronomical Column:—
Comets . . . 66
The Blink Microscope . . . 66
Irrigation in Egypt and the Sudan. By Dr. Brysson Cunningham . . . 67
University and Educational Intelligence . . . 67
Societies and Academies . . . 68
Books Received . . . 68

Editorial and Publishing Offices:
MACMILLAN AND CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.
Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.